

AD

TECHNICAL REPORT

75-45-AMEL

DATA RETRIEVAL AND PROCESSING SYSTEM

A USER'S GUIDE

by

J.P. Ahladas

Hamilton Standard

Division of United Aircraft

Contract No. DA-19-129-AMC-603 (N)

January 1975

**Approved for public release;
distribution unlimited.**

**UNITED STATES ARMY
NATICK LABORATORIES
Natick, Massachusetts 01760**



Aero-Mechanical Engineering Lab

Citation of trade names in this report does not constitute
an official endorsement or approval of the use of such items.

Destroy this report when no longer needed. Do not return it
to originator.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 75-45-AMEL	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Data Retrieval and Processing System - A User's Guide		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) J. P. Ahladas		8. CONTRACT OR GRANT NUMBER(s) DA-19-129-AMC-603(N)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Hamilton Standard Division of United Aircraft Windsor Locks, Connecticut		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS LJ662708D552
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Natick Laboratories Natick, Mass. 01760		12. REPORT DATE January 1975
		13. NUMBER OF PAGES 42
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Data Retrieval Transportation Environment		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report defines the design of a specialized data retrieval system for logging analog data recorded on magnetic tape. It contains a description of the system, system interconnections, a list of equipment, and calibration and service procedures.		

FOREWORD

The original work that resulted in the Data Retrieval and Processing System was conducted by the Hamilton Standard Division of United Aircraft under Contract No. DA-19-129-AMC-603(N), Project No. 1K643324D587. Project Officer and Alternate Project Officer for the U. S. Army Natick Laboratories were Mr. Matthew Venetos and Mr. Denis O'Sullivan, both formerly of the Engineering Sciences Division of the General Equipment and Packaging Laboratory.

Subsequent investigations and refinements, funded under Project No. 1J662708D552, were conducted by Mr. Clive Nickerson, Principal Investigator, formerly of the Engineering Sciences Division of the General Equipment and Packaging Laboratory.

TABLE OF CONTENTS

	<u>Page No.</u>
Introduction	1
General Description	1
Specifications	2
Theory of Operation	3
A. Polarity Sense and Gate Generation	3
B. Initial System Reset	3
C. Print Cycle	4
Description of Equipment	6
Description of Plug-In Modules	6
Control Panel 11-1-2518	6
Peak Memory Driver 11-1-2508	7
Peak Memories 11-1-2515	7
Zero Crossing Detectors 11-1-2510	8
Output Amplifier 11-1-2512	9
Multiplex Switch 11-1-2517	10
Peak Memory Switch Driver 11-1-2514	10
Arbitrary Function Circuit 11-1-2511	11
Summing Amplifier 11-1-2509	12
Column Gate Driver 11-1-2507	12
Calibration Procedure	12
Operating Instructions	14
Trouble Shooting	14
Data Recording and Playback	15
List of Plug-In Modules for Programmer	17
List of Drawings and Manuals	18
Appendix - Electrical Schematics	19

DATA RETRIEVAL AND PROCESSING SYSTEM

A USER'S GUIDE

INTRODUCTION

This system is intended to reproduce data acquired by magnetic tape recorders installed in shipping containers. The parameters recorded are impact velocity, temperature, humidity, static force and dynamic load as a function of time.

Data is recorded in form of pulses whose amplitude and polarity is proportional to the parameter being measured.

Recordings are made with the tape in stationary position. The tape moves 1.6mm between data pulses.

Impact height is computed by the system from the three axis impact height components.

This data retrieval system accepts four parallel data channels which are recorded on magnetic tape. Three of these contain analog data and the fourth channel contains timing information. Each analog data point consists of either a positive leading and a negative lagging or a negative leading and a positive lagging pulse in which the peak magnitude is proportional to some physical quantity. The amplitude and polarity of the leading data pulse is recognized, measured and recorded by the system. A fourth analog data channel is generated in the system by combining the height vectors from the three height channels. At least one of the four input channels from the tape must contain information before the system will generate a read command. An uncertainty of pulse polarity and amplitude exists when first starting the system. Therefore, the first data point into the system from the tape after start-up is used to reset the system to its "ready" state and consequently is not recorded.

GENERAL DESCRIPTION

The system consists of a control panel, a tape playback unit, a programmer, an analog-to-digital converter, a high-speed electro-optical printer and power supply racks.

With the exception of the programmer and the control panel, all equipment was commercially available.

The programmer serves to interface and control the various equipment. Some special circuitry used in this unit for signal conditioning and control are built on plug-in boards similar to the purchased logic plug-in boards.

SPECIFICATIONS

1. Input voltage range to programmer ± 0.137 to $\pm 2V$.
2. Tape playback speed 1-7/8 IPS (4.75cm/sec).
3. Logging Rate - 30 Lines/Sec./150 data channels/Sec. nominal - 100 Lines/Sec. maximum.
4. System accuracy $\pm 1\%$ FS (excluding tape playback equipment).
5. Linearity $\pm 1\%$ FS best straight line.
6. Stability .05%/Day constant temp.
.01%/°C
7. Input power 105-135V, 10A at 60 HZ.
8. Number of input channels: 3 data channels plus time channel. A fourth data channel is generated internally by combining drop height vectors from the 3 input data channels.

In order that tape drop-out errors be reduced to a minimum, a high quality instrumentation tape should be used for recording the data.

THEORY OF OPERATION

For the discussion that follows refer to the system logical schematic 11-1-2505 and the timing diagram 11-1-2506 available in appendix.

A. POLARITY SENSE AND GATE GENERATION

Let it be assumed that the system is in the reset state, that a data point from channel 1 is entering into PB1A1 and that its leading pulse is positive. The pulse is amplified by the peak memory driver PB1A1 and applied simultaneously to the peak memories and the polarity sense zero crossing detectors. Operational trigger PB3A2 is biased to saturation by a negative bias potential, PB3A1 is biased to saturation by a positive bias. The positive incoming pulse will overcome the negative bias on PB3A2 and PB3A2 will switch states causing one shot PB24SS2 to generate a 5 microsecond pulse. This pulse is used for setting the positive peak memory store flip-flop, reset the system if this is the first data pulse entering the system after start-up, or initiate a print command through PB3OSS2.

The positive pulse that triggered PB24SS2 is also applied to PB3A1, but since this operational trigger is already saturated by a positive forward bias it will have no effect on the output of this operational trigger.

The 5 microsecond pulse from PB24SS2 is applied simultaneously to PB27NAND2 and PB32ACOR1-4. Input 9 of PB27NAND2 is forward biased by PB23FF1. The incoming pulse to pin 8 of PB27NAND2 will pass through PB27NAND2; PB23FF2 will be set and the positive peak memory will be unclamped which allows the storage capacitors in the memory to charge the peak amplitude of the positive incoming pulse. A short time later the negative pulse of the data will trigger PB3A1 by overcoming its positive bias, PB3A1 will switch states and generate a 5 microsecond pulse via PB24SS1. This pulse, however, is ignored since PB27NAND1 is inhibited by PB23FF2 being in the set state. For a negative initial pulse PB23FF1 would be set first and would inhibit PB27NAND-2 and the positive peak memory.

B. INITIAL SYSTEM RESET

The system becomes operational when SW3 is actuated. SW3B opens to forward bias PB20NAND5 to permit control gates to initiate printing action, and SW3A closes to discharge C1. When C1 discharges, a pulse is generated that resets PB26FF3 and triggers PB51SS3 to generate a 15 microsecond reset pulse that is applied to all flip-flops and the printer. This pulse closes the peak memory clear gates and resets them to zero. It resets the sequencing flip-flops in the multiplexer so that switch Ch1 is closed and it resets the printer to column number 1. The first pulse from PB32ACOR1-4 will set PB26FF3 and trigger PB3OSS2. In setting, PB26FF3 will trigger PB3OSS1. A 10 millisecond pulse

is applied to pin 6 of PB20NAND5 from PB30SS1, via PB31IA1. The 10 millisecond pulse inhibits PB20NAND5; hence the first initial print command is inhibited. The lagging edge of the 10 millisecond pulse triggers PB51SS3 to generate a reset pulse for resetting the peak memories that may have been charged up by the first data pulse.

C. PRINT CYCLE

Subsequent pulses coming from PB32ACOR1-4 will not affect PB26FF3, but these pulses will trigger 2 millisecond time delay PB30SS2. The function of this time delay is twofold. First, it gives sufficient delay for the counter to register the timing pulse and second, it gives the peak memory sufficient time to charge to the peak value in the event of tape head misalignment.

At the end of the two-millisecond delay PB30SS3 is triggered and generates a 5 microsecond pulse which resets and sets PB26FF4. In setting, PB26FF4 triggers PB51SS2 via PB45DCOR5, PB31IA3 and PB51SS1. The output of PB51SS2 is the print command to the printer. Upon receipt of the initial print command, the printer prints column No. 1 which is the thousands digit for the time. It is obvious that more than one pulse can come from PB32ACOR1-4 in any given print cycle. But only the first pulse initiates the print cycle because once PB26FF4 sets, additional pulses to its set input have no effect on its state.

When the printer is reset, it moves to column No. 1, PB33AND1 is activated, and it in turn activates gates PB46AND5 through PB46AND8 to couple the binary bits of the thousand digits on the time counter to the printer via DCOR gates PB42DCOR2 through PB45DCOR2. After printing the thousand digits in column No. 1, the printer will move to column No. 2; in doing so PB33AND1 will be inhibited and PB33AND2 will be activated. Gates PB46AND5 through 8 will be inhibited and gates PB46AND1 through 4 will be activated and binary information of the 100 units of the time counter is coupled to the printer. On activation, PB33AND2 will also trigger 10 microsecond delay PB51SS1; after 10 microseconds PB51SS2 is triggered which in turn generates a print command, so that binary information on column No. 2 is printed. The 10 microsecond delay of the print command is necessary to allow binary information coupled to the printer to reach steady state. Upon printing of column No. 2, columns No. 3 and 4 (10's and units) will be printed in similar manner. After column No. 4 has been printed, PB33AND4 is inhibited, and PB34AND1 is activated. A digitize command is now applied to the ADC converter through PB45DCOR. Upon receipt of this command, the ADC will digitize the data of channel No. 1. After completion of the digitization cycle, the ADC delivers a "space" command to the printer. The printer leaves a blank on column 5 and moves to column 6. Gate PB34AND2 will now be activated which in turn will activate gates PB45AND1 through 4 to couple to the printer binary information representing polarity sign of the first channel. The 10 microsecond print command delay is also

triggered so that at the end of 10 microseconds the printer will print either a blank indicating a positive quantity or a minus sign for a negative quantity on channel No. 1. At the same instant the sign polarity gates PB40AND1 are activated, PB19FF1 is pulsed causing the sequencing flip-flops to open channel 1, the system will proceed to print the 100's, 10's and units on the ADC in a similar manner as for the time counter. On columns No. 10, 15 and 20, the ADC will receive a command to digitize and on columns 11 and 16 the sequencer will receive a command to step to channels 3 and 4 respectively.

If height data is not required, SW2 is set to the four channel mode. When the printer reaches column No. 20, the output of PB38AND4 is coupled to the reset line through PB42DCOR5, PB31IA2, and PB57DR2. The system now is reset; that is, the peak memories are discharged (set to zero); the multiplexer is set to channel 1; PB26FF4 sets to await the next initial print command, and the printer resets to a new line and column No. 1.

When height computation data is required, the system will print 5 channels of information, and system reset will occur when the printer reaches column 24.

The column decoder gates, PB33AND1 through PB39AND4, provide a digital feedback loop with positive control on the entire system. The entire system is reset for each line of recorded data and cannot remain out of synchronization for more than one line of printout.

DESCRIPTION OF EQUIPMENT

The Monroe MC400N optical printer is capable of printing up to 100 lines per second. It accepts four parallel bit characters serially with -12 volt true logic and 0V false logic. Printing is done on Kodak Linagraph Direct Print oscillograph paper, type 1855, Spec. 111.

The analog-to-digital convertor (ADC) is a Beckman Model 4040A which accepts 10 volts full scale input with a 1.33K per volt input impedance and has an 8-4-2-1 binary coded three-digit decimal output (13 binary digits including the sign). The output of this unit is also -12 volt true and 0 volt false. The maximum time per conversion is 51 microseconds.

Temperature and humidity plotter outputs are provided for graphically recording the history of a package over the time of shipment or storage. A Honeywell Electro Instruments Model 400 plotter is used with vertical differential amplifier (maximum sensitivity: 1 mv/inch) and time base (0.02 to 2 inches/sec.) plug-ins. Response of this unit is 3 db down at 5 Hz. Plots are made on 11 x 17 inch graph paper.

A description of the programmer and its function for system control and interfacing of equipment is given in the "Theory of Operation" section. For more detailed information on the other units, the manufacturers' manuals should be consulted.

DESCRIPTION OF PLUG-IN MODULES

A description and function of the analog modules and multiplex switch is given in this manual. Plug-in digital modules are described in the manufacturer's module manual which should be referenced whenever information is required on the digital modules. These modules are generally of the DTL type, using discrete components and -12 volt true and 0 volt false logic levels.

CONTROL PANEL - 11-1-2518

As the name implies, this unit provides the necessary controls for turning the power on and off, selecting the mode of operation, starting and stopping the system, and selecting the desired channel for monitoring on the scope.

On depressing the log/standby switch for the logging operation, the unit first starts the tape transport. After full speed is reached by the tape transport the unit resets the system and activates NAND gate PB20NAND5 in the programmer to allow logging operation. On setting the system on "standby", the print control gates are first deactivated, then the tape transport is turned off. This procedure avoids erroneous print-outs of data.

Control of the system is accomplished as follows:

When SW1 is pressed to the "log" position, C1 charges through SW1A CR1 and R2 and K1 energizes. SW1C closes and the contacts of K1 open to turn on the tape transport. C2 also charges, but at much lower rate, through R1 and CR2. After about one second delay, the voltage across C2 overcomes the zener voltage of CR3, and K2 is energized. K2 energizes mercury relay K3. When K3 is energized, pin No. 5 swings to -12V to activate the print control gate PB2ONAND5 in the programmer. Pin No. 3 is shorted to ground. C3 delivers a positive pulse to the programmer for resetting the system.

When SW1 is set to the standby position, K3 de-energizes. PB2ONAND5 in the programmer is inhibited, thus preventing initial print commands from reaching the printer. The charge on C1 prevents K1 from de-energizing until a few milliseconds later. This guarantees that the tape transport is always at full speed while the system performs the logging operation. Mode control is accomplished through SW2A and SW2B by connecting the reset gate to the proper column on the column decoder gate. Deck SW2C switches the correct scaling factor the output amplifier, thus minimizing calibration time when switching tapes.

The lines of SW4 terminate to the output of the tape preamplifier. The arms of SW4 terminate to the oscilloscope, thus permitting channel monitoring.

SW3 is the time override switch. If it is necessary to stop the logger and restart it on the same tape, SW3 is set to "off" position. This will prevent the time counter from resetting to zero when restarting the logger.

PEAK MEMORY DRIVER - 11-1-2508

This unit amplifies the incoming signal and has enough drive capability to rapidly charge the peak memories without overloading. It also drives the zero crossing detectors.

It consists of an operational differential amplifier A1 whose gain is fixed by R1 and R2. The gain of this amplifier is equal to $(R1 + R2)/R1$. A 1.5-volt signal to the input will give a full scale reading on any scale. The three boards this unit drives must be D.C. isolated from each other. Capacitors C1 to C3 are used to provide this isolation.

PEAK MEMORIES - 11-1-2515

This circuit is used for storing the data pulse amplitude until logging is completed.

The peak memories consist of rectifier diodes for polarity sensing, integrated chopper for clamping and an operational voltage follower. The rectifiers CR5 and CR6 are forward biased with approximately 0.4VDC to

overcome the diodes forward barrier voltage. This bias is obtained from the $15 \pm$ volt supplies and is developed across CR2 and CR4. The change in the voltage drop across CR2 and CR4 with temperature, temperature compensates the rectifiers.

Assuming a positive leading data pulse, the bases of Q1 and Q3 will be driven positive. This will cut off Q1 and Q3 and allow the peak memory capacitors C1 and C2 to charge to the peak value of the incoming pulse. One half of the amplitude is applied to the operational voltage follower. The output of this unit is the data signal applied to the ADC via the output amplifier.

For a negative leading data pulse, the negative switches Q2 and Q4 open to allow C3 and C4 to charge.

At the end of the logging cycle the bases of Q1 and Q3 are driven positive. Q1 and Q3 conduct to discharge the peak memory capacitors C1 and C2. The function of Q3 and Q4 is to prevent the operational followers A1 and A2 from drifting due to leakage currents that can flow into C1 and C3 from A1 and A2 respectively.

Resistors R6, R7, R11 and R15 serve to limit the discharge currents from the peak memory capacitors into the integrated choppers. R5 and R14 limit the charging current that can flow from the peak memory driver.

The peak memories are capacitively coupled to the peak memory driver. The coupling capacitors accumulate a small charge during the leading data pulse. R1 CR1 and R9 CR3 act to remove this charge during the lagging data pulse period.

The peak memory is adjusted for zero output with zero input as follows:

Apply power and let stand 1/2 hour. Remove the tape that may be on the tape deck and depress the "Log" switch. Adjust R8 and R16 for zero output at TP1 and TP2.

ZERO CROSSING DETECTORS - 11-1-2510

These units sense the polarity of the incoming pulse and perform a switching function when the incoming pulse exceeds 0.137 volts. The output pulse from these units is used for opening the peak memories and to initiate a readout cycle.

Each unit consists of two high-speed, high-gain differential amplifiers in a positive feedback loop. The output of these amplifiers switches rapidly from plus to minus or from minus to plus when the input exceeds a certain threshold.

The threshold voltages of 0.137 volts are obtained from the ± 15 V supplies and voltage dividers R1, R2, R3 and R4.

A1 is biased with 0.137 V from the junction of R1 and R2. Positive feedback is applied to this unit from the junction of R10 and R11. With zero input to pin No. 8, the output of A1 is at the -11 to -14 volt level. When a negative input voltage to pin No. 8 exceeds the positive threshold voltage of 0.137 by about 10 MV, the output of A1 switches from minus to plus 11 to 14 volts.

A2 is biased with a negative bias of 0.137 V. Its output with zero input is +11 to +14 V. When the input to pin 8 is greater than 0.137 volts, A2 switches from plus to minus 11 to 14 V. An inverter consisting of Q1, CR5, R16, R17 and R15 follows A2. It is necessary to invert the pulse from A2 since the logical circuitry following these units responds to positive going pulses.

CR1 through CR4 prevent damage to the amplifier through excessive input voltages.

This unit is initially adjusted as follows:

With power applied, the plus and minus inputs of each amplifier are shorted to the common. R9 and R8 are then adjusted until the output of each amplifier is zero, as measured at TP1 and TP2.

OUTPUT AMPLIFIER - 11-1-2512

This unit combines the negative or positive data input from the peak memories and provides the necessary scaling of voltages for readout in engineering units by the ADC.

The input data voltage is divided by R1, R2 and R4 and is reamplified by A1 to the proper level. The correct scale factor is selected by energizing one of the three relays. This connects the feedback resistors around the amplifier for proper scaling.

The gain of the amplifier at either input while the other is shorted is given by

$$A = \left(\frac{R5 + Rf}{R5} \right) \left(\frac{R4}{R_{in} + R4} \right)$$

Where Rf is the feedback resistance, R6 + R7, for example. When K2 is energized, the amplifier is scaled to read temperature in degrees F.

With zero input the amplifier output is -.5 V representing -50°F. The transfer function of the amplifier under the "temperature" mode is given by

$$E_o = .25 (E_i - 2.0)$$

The 2.0 V offset is provided by the R12 - R13 divider. Negative tem-

peratures from -50°F through -1°F will print out 950 through 999. Subtract print-out from 1,000 to determine the correct value in this range.

These units are initially adjusted as follows: Pins 8 and 10 are shorted to common. R3 is then adjusted for zero output on pin 16.

An adjustable zero offset is provided in the drop height playback mode to compensate for any apparent negative offset caused by the non-linearity on the lower part of the drop height-playback voltage.

Adjustment procedure is as follows:

1. Graphical determination of intercept of drop height-playback voltage curve by extension of linear portion of the curve through the zero drop height line.

2. Computation of equivalent print-out from the intercept value. $\text{Print-out} = 320 \times \text{Intercept (volts)}$.

3. Setting of the extra potentiometer (mounted on an operational amplifier) on PB9 so that with zero input into PB4, PB9 and PB14, the print-out in channels 1, 2 and 3 agrees with the determined print-out.

For calibration of these units refer to the calibration procedure.

MULTIPLEX SWITCH - 11-1-2517

This unit sequentially connects the four data channels to the ADC for digitalization.

The inputs from the sequence NAND gates are fed to the integrated chopper bases. The logical connection to the sequence NAND gates are such that only one integrated chopper is forward biased at any one time. When the system is in reset state, Q1 is forward biased with the remaining integrated choppers off.

The conducting chopper has an "on" resistance of about 10 ohms with a typical offset voltage between E1 and E2 of less than 5 MV. The "off" resistance of these units is greater than 500 megohms.

PEAK MEMORY SWITCH DRIVER - 11-1-2514

This circuit converts the memory set flip-flop voltage levels to those required for driving the integrated chopper clamp.

When Q1 and Q2 are off, their collector voltage swings to the +24 V supply, opening the integrated choppers in the peak memory.

The drivers are cut off when the input to the bases is between -9 to -12. They become saturated when the input to their bases is

at ground potential. When the drivers are driven to saturation, their collectors swing toward -9 V DC. This forward biases the integrated choppers in the peak memories and prevents the memory capacitors from charging.

Three similar units are built on a single plug-in board.

ARBITRARY FUNCTION CIRCUIT - 11-1-2511

This circuit has an adjustable transfer characteristic consisting of eleven straight-line segments whose slopes are set by potentiometric screwdriver adjustments on a Philbrick/Nexus SPFX-P arbitrary function transconductor module. The initial slope is fixed at 45° by a 20K resistor across pins 9 and 10 of the SPFX-P module. A differential subtractor amplifier (PBX01) is used to allow arbitrary conditioning of both positive and negative outputs of memory, and an additional inverting amplifier (PBX02) follows the module to allow both positive and negative changes in slope.

These features are incorporated into the read-out unit to allow compensation for non-linear playback behavior. Setting of the arbitrary function so that it is the inverse of the input function serves to linearize the overall characteristic.

The initial slope interval is between 0.0 and +0.5 volts input. Subsequent segments are in 1-volt input increments up to 9.5 volts. The final segment is from +9.5 volt to +10 volt input. The largest incremental slope change allowed is 0.4V/V.

The procedure for use of this circuit follows:

1. Draw the inverse of the function to be fitted.
2. Determine the incremental slope changes necessary to obtain the inverse.
3. Using the test card in place of the peak memory board in the channel to be adjusted, feed in a low frequency sine wave of 8 volts peak amplitude into the memory No. 1 terminal while grounding memory No. 2 terminal on test card.
4. Monitor input (sine wave) and output of arbitrary function circuit at test point on PB5, PB10 or PB15 using an X-Y oscilloscope display.
5. Adjust SPFX-P module by setting potentiometers 1 through 8 in order, so that the incremental slopes on the X-Y display agree with those determined for the function inverse.

SUMMING AMPLIFIER - 11-1-2509

This unit sums and scales height inputs. It performs the mathematical operation of

$$V_o = A (V_{11} + V_{22} + V_{33})$$

Where V_{11} , V_{22} and V_{33} are the voltages from the arbitrary function circuits, the output of this amplifier is then analog to

$$h = \frac{V_1^2 + V_2^2 + V_3^2}{2g} = h_x + h_y + h_z$$

The gain of this stage is given by

$$A = \frac{R_6 + R_7 + R_4}{R_4}$$

This unit is initially adjusted as follows: Pins 8, 9 and 10 are shorted to the common, and R_5 is adjusted for zero output at TPL. When shorting pins 8, 9 and 10 to common, be sure the arbitrary function circuits are removed or disconnected from these pins.

COLUMN GATE DRIVER - 11-1-2507

This circuit is used to increase the driving capability of the printer column decoder lines.

The driver is a Darlington, complementary push-pull emitter follower capable of driving 90 AND gates. CR1 and CR2 provide a slight forward bias to the drivers, Q2 and Q3, to increase the unit's speed of response. In the event the drop across the biasing diodes is high compared to the forward base drop of Q1 and Q2, R4 limits the collector current of Q1 and Q2 from becoming high while the driver is in its quiescent state. R1 limits the power dissipation and collector current of Q2. The voltage gain of this circuit is between 0.85 and 0.95 with 0 to -10 V at the base of Q1 and a 120 ohm load at the output.

CALIBRATION PROCEDURE

After a half-hour warmup period the read-out unit should be calibrated according to the following procedure:

1. Zero amplifiers in the following sequence with the inputs to channels 1, 2 and 3 all shorted to ground.

- a. Input amplifiers (PB1, PB6, PB11)
- b. Memories (PB2, PB7, PB12)
- c. PBX01 outputs (use test card)
- d. PBX02 outputs (use test card)
- e. Arbitrary function output (PB5, PB10, PB15)
- f. Output amplifiers (PB4, PB9, PB14) (Set to load mode and use test card.)
- g. Summing amplifier (PB16) (Set to load mode.)

2. Check and adjust the arbitrary functions using a sine wave input into the test card for linear transfer characteristics or adjust to the desired non-linear characteristics.

3. Check and adjust the offset for zero in the drop height mode or adjust to desired offset.

4. Set the mode switch to drop height and feed in a 1.5 volt, 400 microsecond, 30pps pulse train into channel number 1 while other channels are shorted.

5. Adjust the output amplifier (PB4) drop height potentiometer and the summing amplifier (PB16) potentiometer for print-outs of 480.

6. Repeat 1. through 5. for channel 2 (PB9) and channel 3 (PB14).

7. Switch to the temperature/humidity mode.

8. Feed the above signal into channel 1 and adjust the output amplifier (PB4) temperature potentiometer for print-out of 150.

9. Feed into channel 2 and adjust for a print-out of 100.

10. Feed into channel 3 and adjust for a print-out of 600.

Before each use of the read-out unit to retrieve drop height or temperature/humidity static load information, the playback tape deck output amplifiers should be adjusted to yield 1.5 volts out for the following recorded information that is applicable:

Drop Height	48 inches (122cm)
Temperature	150°F (65.6°C)
Humidity	100%
Static Load	6,000 pounds (2,718 Kg)

OPERATING INSTRUCTIONS

1. Turn on power on all equipment and allow 1/2-hour warmup on standby mode.
2. Place data tape on tape deck.
3. Place all tape deck push button controls on their "off" position.
4. Select the mode of operation to correspond to the data tape with the mode selector switch on the control panel.
5. Depress the standby-log switch to the log position for commencing the logging operation.
6. The system will automatically cease logging when the tape reel is finished.
7. To stop the logging cycle, depress the standby-log switch to the standby position.

TROUBLE SHOOTING

Trouble shooting time can be shortened considerably if it is well understood how the system functions. Therefore, the system description and logical schematic should be carefully studied. Once the system is well understood, "effect-to-cause" reasoning and through waveform observation at various test points provided should quickly locate the defect.

The first steps in trouble shooting should be to check all power supply outputs. In many cases, a readjustment of power supply settings will correct the malfunction.

Because semiconductors are used exclusively, resistance measurements on a normal or defective circuit can exhibit a wide range of deviations, depending on the ohmmeter used, polarity connections, and the ambient temperature. Resistance measurements are not recommended. A good oscilloscope with 2 or more simultaneous traces is the most effective service tool for localizing the trouble.

The defective circuit or unit can be easily traced by referring to the timing waveform diagram drawing 11-1-2506 and 11-1-2516.

When trouble is located in one of the commercial units, the manufacturer's manual for that particular unit should be consulted.

It is recommended that the circuit used for calibrating the system be also used for trouble shooting. The normal waveforms at various test points specified on 11-1-2516 with the input data pulse on channel 1 are shown on this drawing.

If printing action stops after printing the time channel or at columns No. 5, 10, 15 and 20; the trouble is either with the column decoder or the ADC. If no readout occurs or the system stops at some other column, the trouble is either in the column decoder or the printer.

With a negative input data pulse, waveforms No. 1 and 2 on 11-1-2516 are reversed in polarity.

Waveform No. 2 appears on PB2TP2. Waveforms 3 through 6 appear on PB3TP1, PB24TP3, PB27TP6 and PB23TP4, respectively.

Waveforms 7 through 21 will appear at the same test points, regardless of the channel being tested or the polarity of the input data pulse.

The waveforms shown on timing diagram 11-1-2506 are essentially the waveforms that appear on the column decoder. Waveform No. 1, for example, should appear on PB33TP6. Waveform No. 5 appears on PB34TP1, PB37TP6, PB38TP4 and PB39TP4 with one pulse on each test point for every readout cycle.

The table which follows lists the programmer test points for waveforms 1 to 6 for checking out the three channels with negative and positive data pulses. All waveforms should have similar characteristics shown on 11-1-2516, except waveforms 1 and 2 should be reversed in polarity with negative input data pulses.

Input Data Pulse	Waveform No.					
	1	2	3	4	5	6
Ch. #1 Pos.	PB1TP1	PB2TP1	P33TP2	PB24TP2	PB27TP5	PB23TP3
Ch. #1 Neg.	PB1TP1	PB2TP2	PB3TP1	PB24TP3	PB27TP6	PB23TP4
Ch. #2 Pos.	PB6TP1	PB7TP1	PB8TP2	PB24TP1	PB27TP3	PB23TP1
Ch. #2 Neg.	PB6TP1	PB7TP2	PB8TP1	PB25TP3	PB27TP4	PB23TP2
Ch. #3 Pos.	PB11TP1	PB12TP1	PB13TP2	PB25TP1	PB27TP1	PB26TP3
Ch. #3 Neg.	PB11TP1	PB12TP2	PB13TP1	PB25TP2	PB27TP2	PB26TP4

DATA RECORDING AND PLAYBACK

It is recommended that the recording head gap be 0.001" (.025mm). A wider gap will cause cross talk between channels and partial erasure from data point to data point.

A smaller recording head gap will reduce the pulse width. This will require shorter peak memory responses, which could result in poorer noise rejection by the system and also increase tape dropout errors.

The reproduce heads should have a narrow gap for good high frequency response. The 4-channel standard playback heads as installed by Precision Instruments on their tape transport units are satisfactory in this respect.

LIST OF PLUG-IN MODULES REQUIRED FOR PROGRAMMER

Programmer cabinet is Raytheon MCR-75-500

<u>Type</u>	<u>No. Required</u>		<u>Drawing or Manufacturer</u>
GDG2-.2	10	Diode AND Gate	Raytheon
GDG3-.2	4	D.C. OR Gate	Raytheon
GFF1-.2	3	Flip-Flop	Raytheon
GLG1-.2*	2	A.C. OR Gate	Raytheon
GOS3-.2	4	One Shot	Raytheon
GNA1-.2	2	NAND Gate	Raytheon
GST2-.2	1	Schmitt Trigger	Raytheon
GDC1-.2	4	Decade Counter	Raytheon
GAI2-.2	1	Inverting Amplifier	Raytheon
GRG1-.2	1	Reset Gate	Raytheon
700125	3	Peak Memory Driver	Hamilton Standard
700131	1	Peak Memory Switch Driver	Hamilton Standard
700132	3	Peak Memory	Hamilton Standard
700127	3	Zero Crossing Detector	Hamilton Standard
700128	3	Arbitrary Circuit	Hamilton Standard
700126	3	Summing Amplifier	Hamilton Standard
700129	1	Output Amplifier	Hamilton Standard
700134	2	Multiplex Switch	Hamilton Standard
700124	4	Column Gate Driver	Hamilton Standard
700137	1	A.C. OR Gate	Hamilton Standard
700139	1	Low Pass Filter	Hamilton Standard

*One of these gates is modified per Drawing 11-1-2520.

LIST OF DRAWINGS AND MANUALS

<u>Number</u>	<u>Title</u>
11-1-2505	System Logical Schematic
11-1-2506	Timing Diagram
11-1-2507	Column Gate Driver PB48, PB49, PB50 and PB57
11-1-2508	Peak Memory Driver PB1, PB6 and PB11
11-1-2509	Summing Amplifier PB16
11-1-2510	Zero Crossing Detector & Gate Generator PB3, PB8 & PB13
11-1-2511	Arbitrary Function PB5, PB10 and PB15
11-1-2512	Output Amplifier PB4, PB9 and PB14
11-1-2513	Programmer Power Supply Connections
11-1-2514	Peak Memory Switch Driver PB28
11-1-2515	Peak Memory PB2, PB7 and PB12
11-1-2516	Trouble Shooting Timing Diagram
11-1-2517	Multiplex Switch PB17 and PB18
11-1-2518	Control Panel
11-1-2519	Programmer Wiring Diagram
11-1-2520	A.C. OR Negative Input PB32
11-1-2521	System Wiring Diagram
11-1-2522	Recorder Filter PB21
Model 404DA	ADC Manual, Beckman Instruments
Model 4000	Printer Manual, Monroe Data/Log.
Model PI6001	Tape Transport Manual, Precision Instruments
Model SPFX-P	Arbitrary Function Transconductor Philbrick/Nexus
LM	Power Supply-Series-Specifications, Lambda Electronics
CPM 3001	Modules Manual - Raytheon

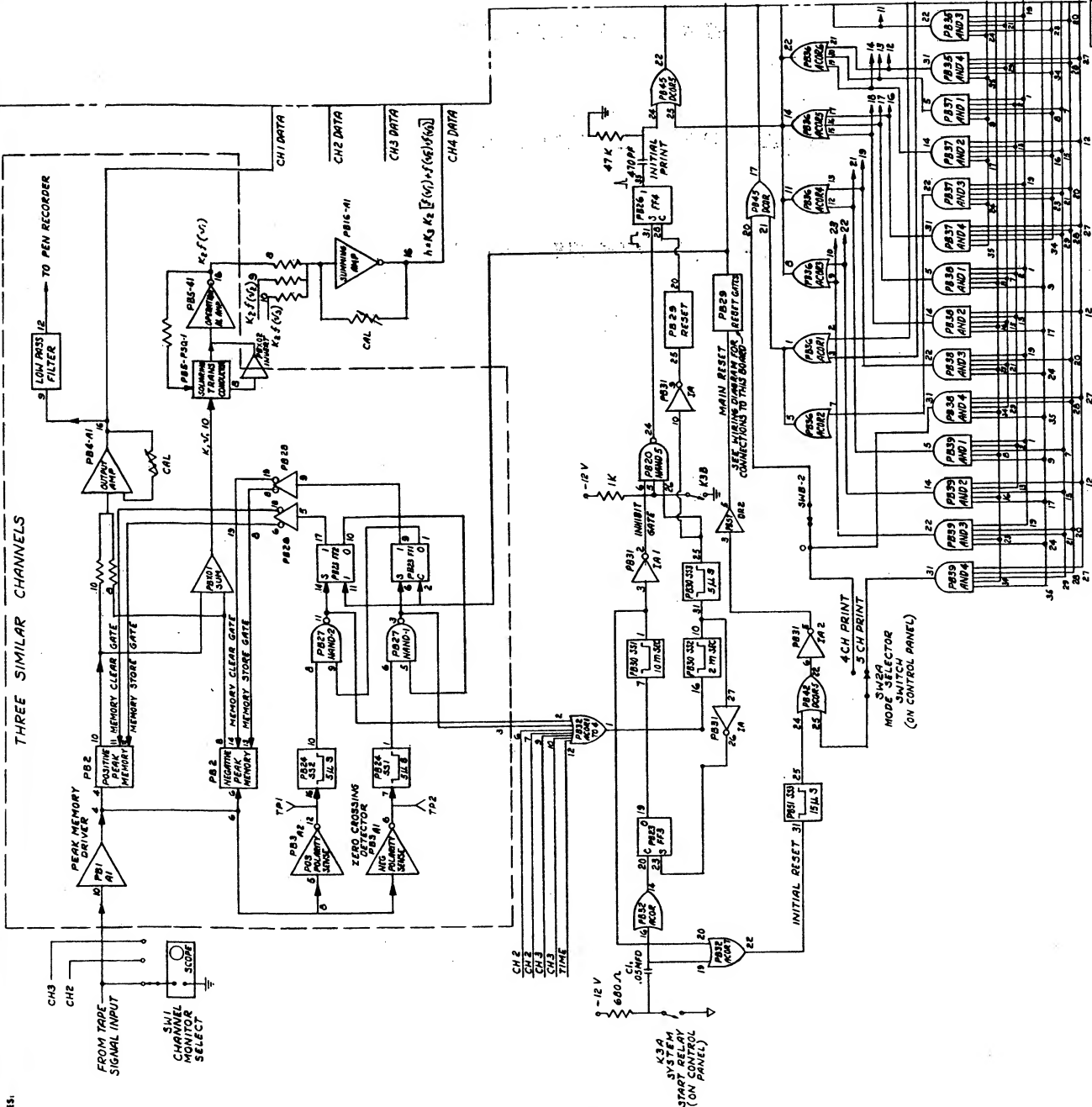
APPENDIX

ELECTRICAL SCHEMATICS

US ARMY NATICK LABORATORIES DRAWINGS

11-1-2505 THROUGH 11-1-2522

THREE SIMILAR CHANNELS

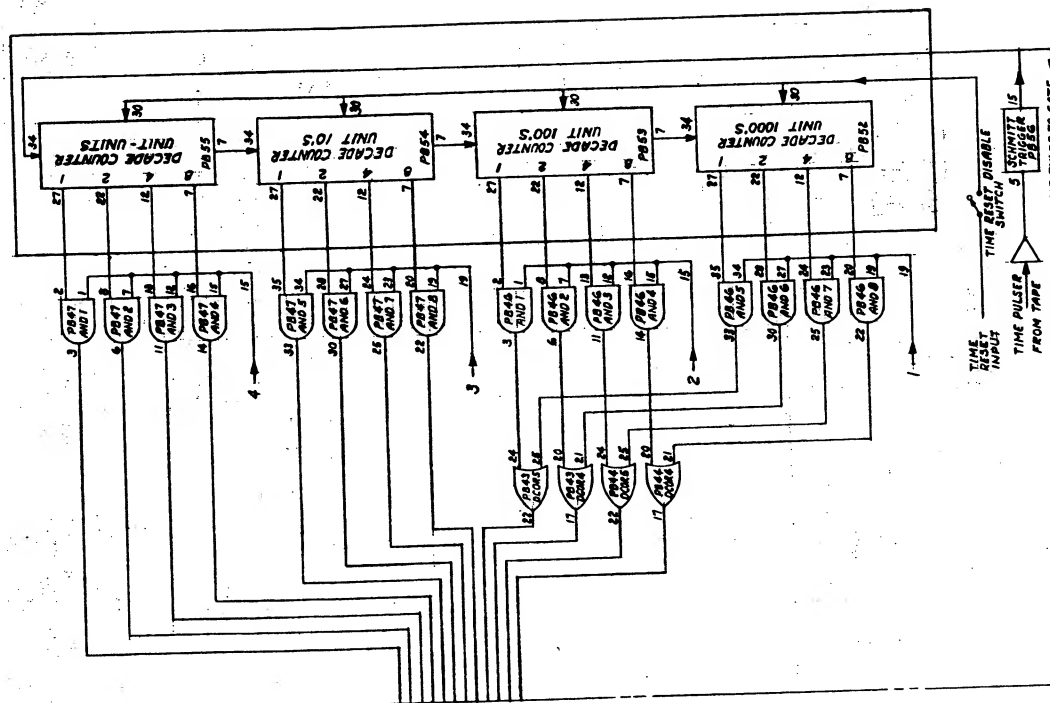


COLUMN GATE DECODER

ITEM NO.	QTY	CODE	DATE	DESCRIPTION	REVISION NO.	MATERIAL	DATE	APPROVED	DATE	APPROVED
1	1			INITIAL RESET						
2	1			MOD SELECTOR						
3	1			4 CH PRINT						
4	1			5 CH PRINT						
5	1			MOD SELECTOR						
6	1			MOD SELECTOR						
7	1			MOD SELECTOR						
8	1			MOD SELECTOR						
9	1			MOD SELECTOR						
10	1			MOD SELECTOR						
11	1			MOD SELECTOR						
12	1			MOD SELECTOR						
13	1			MOD SELECTOR						
14	1			MOD SELECTOR						
15	1			MOD SELECTOR						
16	1			MOD SELECTOR						
17	1			MOD SELECTOR						
18	1			MOD SELECTOR						
19	1			MOD SELECTOR						
20	1			MOD SELECTOR						
21	1			MOD SELECTOR						
22	1			MOD SELECTOR						
23	1			MOD SELECTOR						
24	1			MOD SELECTOR						
25	1			MOD SELECTOR						
26	1			MOD SELECTOR						
27	1			MOD SELECTOR						
28	1			MOD SELECTOR						
29	1			MOD SELECTOR						
30	1			MOD SELECTOR						
31	1			MOD SELECTOR						
32	1			MOD SELECTOR						
33	1			MOD SELECTOR						
34	1			MOD SELECTOR						
35	1			MOD SELECTOR						
36	1			MOD SELECTOR						
37	1			MOD SELECTOR						
38	1			MOD SELECTOR						
39	1			MOD SELECTOR						
40	1			MOD SELECTOR						
41	1			MOD SELECTOR						
42	1			MOD SELECTOR						
43	1			MOD SELECTOR						
44	1			MOD SELECTOR						
45	1			MOD SELECTOR						
46	1			MOD SELECTOR						
47	1			MOD SELECTOR						
48	1			MOD SELECTOR						
49	1			MOD SELECTOR						
50	1			MOD SELECTOR						
51	1			MOD SELECTOR						
52	1			MOD SELECTOR						
53	1			MOD SELECTOR						
54	1			MOD SELECTOR						
55	1			MOD SELECTOR						
56	1			MOD SELECTOR						
57	1			MOD SELECTOR						
58	1			MOD SELECTOR						
59	1			MOD SELECTOR						
60	1			MOD SELECTOR						
61	1			MOD SELECTOR						
62	1			MOD SELECTOR						
63	1			MOD SELECTOR						
64	1			MOD SELECTOR						
65	1			MOD SELECTOR						
66	1			MOD SELECTOR						
67	1			MOD SELECTOR						
68	1			MOD SELECTOR						
69	1			MOD SELECTOR						
70	1			MOD SELECTOR						
71	1			MOD SELECTOR						
72	1			MOD SELECTOR						
73	1			MOD SELECTOR						
74	1			MOD SELECTOR						
75	1			MOD SELECTOR						
76	1			MOD SELECTOR						
77	1			MOD SELECTOR						
78	1			MOD SELECTOR						
79	1			MOD SELECTOR						
80	1			MOD SELECTOR						
81	1			MOD SELECTOR						
82	1			MOD SELECTOR						
83	1			MOD SELECTOR						
84	1			MOD SELECTOR						
85	1			MOD SELECTOR						
86	1			MOD SELECTOR						
87	1			MOD SELECTOR						
88	1			MOD SELECTOR						
89	1			MOD SELECTOR						
90	1			MOD SELECTOR						
91	1			MOD SELECTOR						
92	1			MOD SELECTOR						
93	1			MOD SELECTOR						
94	1			MOD SELECTOR						
95	1			MOD SELECTOR						
96	1			MOD SELECTOR						
97	1			MOD SELECTOR						
98	1			MOD SELECTOR						
99	1			MOD SELECTOR						
100	1			MOD SELECTOR						

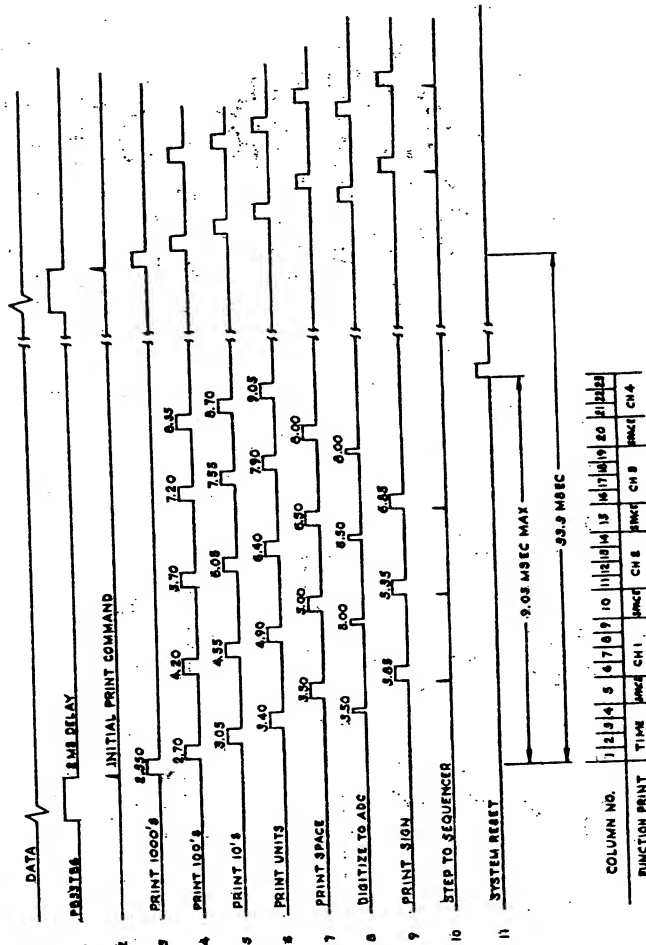
36	29	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27	12	27</
----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	------

NOTES:



ITEM		QTY	CODE	DESCRIPTION	MANUFACTURE IN	NATIONAL	UNIT PRICE	TOTAL
PARTS LIST								
DATE: 5-25-72								
REVISION: 1								
DRAWN BY: J. L. BROWN								
CHECKED BY: J. L. BROWN								
APPROVED BY: J. L. BROWN								
DATE: 11-1-5505								
PAGE: 1								

NOTES:

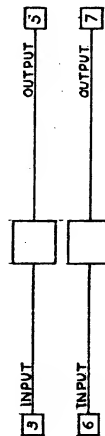
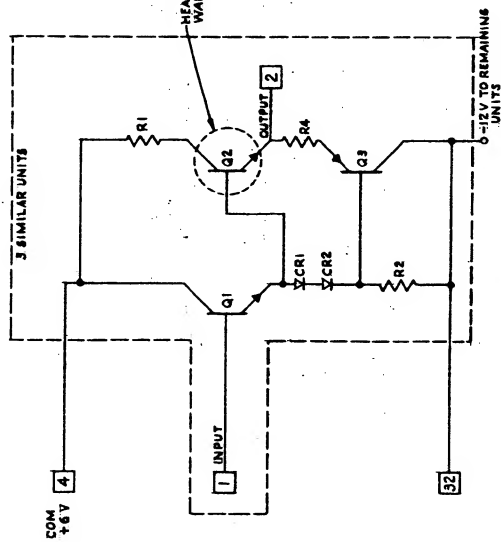


FUNCTION PRINT	TIME	CH 1	CH 2	CH 3	CH 4
COLUMN NO.	1	2	3	4	5
	6	7	8	9	10
	11	12	13	14	15
	16	17	18	19	20
	21	22	23	24	25

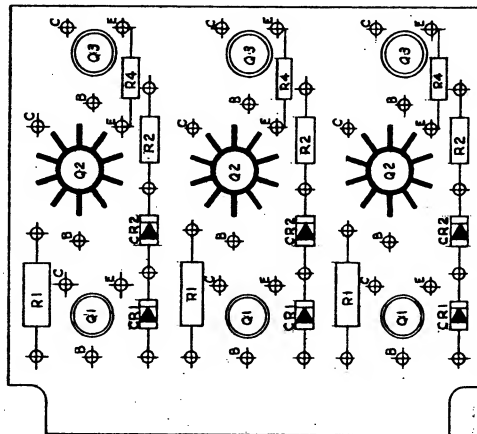
PARTS LIST

ITEM NO.	QTY	CODE	DESCRIPTION	PART NO. OR IDENTIFYING NO.	MATERIAL	UNIT PRICE	EXT. NO.
<p>U.S. ARMY MATHEMATICS LABORATORY MATHEMATICS BRANCH WASHINGTON, D.C. 20315</p>							
<p>DATE: 8-07-74 CHECKED: [Signature] EXAMINED: [Signature] APPROVAL: [Signature]</p>							
<p>U.S. ARMY MATHEMATICS LABORATORY MATHEMATICS BRANCH WASHINGTON, D.C. 20315</p>							
<p>DATA RETRIEVAL SYSTEM TIMING DIAGRAM</p>							
<p>SIZE: 8 1/2" X 11" DRAWING NO. 11-1-2506 SCALE: D 81337 SHEET: 1 OF 1</p>							

NOTES:



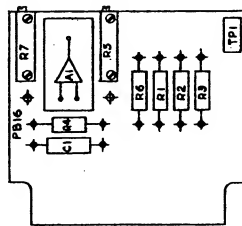
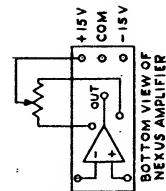
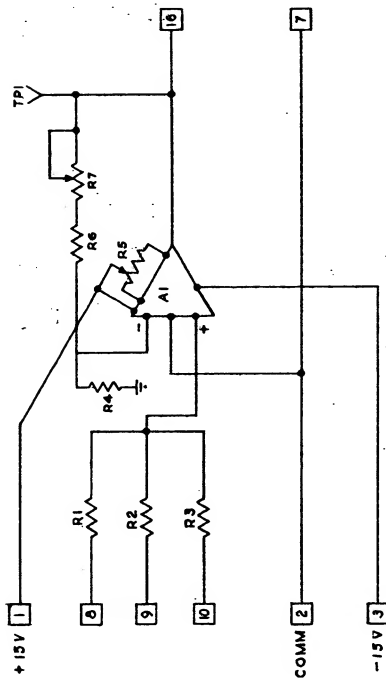
SYM	COMPONENT	VALUE	TOL
CR1	HEAT SINK WAKEFIELD NF205		
CR2	IN643A		
Q1	IN643A		
Q2	2N2219		
Q3	2N2219		
R1	RC20GF30J 33Ω	5%	
R2	RC20GF821J 820Ω	5%	
R4	RC20GF220J 22Ω	5%	
PB1	RAYTHEON PLUG IN BOARD MDS1		



REV	DATE	APPROVED
1		

ITEM NO.	QTY	CODE	DESCRIPTION	PART NO. OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL	NATL. SPEC.	DWG. NO.
PARTS LIST								
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES FRACTIONS: 1/16, 1/8, 1/4, 3/8, 1/2, 5/8, 3/4, 7/8, 1, 1 1/4, 1 1/2, 1 3/4, 2, 2 1/4, 2 1/2, 2 3/4, 3, 3 1/4, 3 1/2, 3 3/4, 4, 4 1/4, 4 1/2, 4 3/4, 5, 5 1/4, 5 1/2, 5 3/4, 6, 6 1/4, 6 1/2, 6 3/4, 7, 7 1/4, 7 1/2, 7 3/4, 8, 8 1/4, 8 1/2, 8 3/4, 9, 9 1/4, 9 1/2, 9 3/4, 10, 10 1/4, 10 1/2, 10 3/4, 11, 11 1/4, 11 1/2, 11 3/4, 12, 12 1/4, 12 1/2, 12 3/4, 13, 13 1/4, 13 1/2, 13 3/4, 14, 14 1/4, 14 1/2, 14 3/4, 15, 15 1/4, 15 1/2, 15 3/4, 16, 16 1/4, 16 1/2, 16 3/4, 17, 17 1/4, 17 1/2, 17 3/4, 18, 18 1/4, 18 1/2, 18 3/4, 19, 19 1/4, 19 1/2, 19 3/4, 20, 20 1/4, 20 1/2, 20 3/4, 21, 21 1/4, 21 1/2, 21 3/4, 22, 22 1/4, 22 1/2, 22 3/4, 23, 23 1/4, 23 1/2, 23 3/4, 24, 24 1/4, 24 1/2, 24 3/4, 25, 25 1/4, 25 1/2, 25 3/4, 26, 26 1/4, 26 1/2, 26 3/4, 27, 27 1/4, 27 1/2, 27 3/4, 28, 28 1/4, 28 1/2, 28 3/4, 29, 29 1/4, 29 1/2, 29 3/4, 30, 30 1/4, 30 1/2, 30 3/4, 31, 31 1/4, 31 1/2, 31 3/4, 32, 32 1/4, 32 1/2, 32 3/4, 33, 33 1/4, 33 1/2, 33 3/4, 34, 34 1/4, 34 1/2, 34 3/4, 35, 35 1/4, 35 1/2, 35 3/4, 36, 36 1/4, 36 1/2, 36 3/4, 37, 37 1/4, 37 1/2, 37 3/4, 38, 38 1/4, 38 1/2, 38 3/4, 39, 39 1/4, 39 1/2, 39 3/4, 40, 40 1/4, 40 1/2, 40 3/4, 41, 41 1/4, 41 1/2, 41 3/4, 42, 42 1/4, 42 1/2, 42 3/4, 43, 43 1/4, 43 1/2, 43 3/4, 44, 44 1/4, 44 1/2, 44 3/4, 45, 45 1/4, 45 1/2, 45 3/4, 46, 46 1/4, 46 1/2, 46 3/4, 47, 47 1/4, 47 1/2, 47 3/4, 48, 48 1/4, 48 1/2, 48 3/4, 49, 49 1/4, 49 1/2, 49 3/4, 50, 50 1/4, 50 1/2, 50 3/4, 51, 51 1/4, 51 1/2, 51 3/4, 52, 52 1/4, 52 1/2, 52 3/4, 53, 53 1/4, 53 1/2, 53 3/4, 54, 54 1/4, 54 1/2, 54 3/4, 55, 55 1/4, 55 1/2, 55 3/4, 56, 56 1/4, 56 1/2, 56 3/4, 57, 57 1/4, 57 1/2, 57 3/4, 58, 58 1/4, 58 1/2, 58 3/4, 59, 59 1/4, 59 1/2, 59 3/4, 60, 60 1/4, 60 1/2, 60 3/4, 61, 61 1/4, 61 1/2, 61 3/4, 62, 62 1/4, 62 1/2, 62 3/4, 63, 63 1/4, 63 1/2, 63 3/4, 64, 64 1/4, 64 1/2, 64 3/4, 65, 65 1/4, 65 1/2, 65 3/4, 66, 66 1/4, 66 1/2, 66 3/4, 67, 67 1/4, 67 1/2, 67 3/4, 68, 68 1/4, 68 1/2, 68 3/4, 69, 69 1/4, 69 1/2, 69 3/4, 70, 70 1/4, 70 1/2, 70 3/4, 71, 71 1/4, 71 1/2, 71 3/4, 72, 72 1/4, 72 1/2, 72 3/4, 73, 73 1/4, 73 1/2, 73 3/4, 74, 74 1/4, 74 1/2, 74 3/4, 75, 75 1/4, 75 1/2, 75 3/4, 76, 76 1/4, 76 1/2, 76 3/4, 77, 77 1/4, 77 1/2, 77 3/4, 78, 78 1/4, 78 1/2, 78 3/4, 79, 79 1/4, 79 1/2, 79 3/4, 80, 80 1/4, 80 1/2, 80 3/4, 81, 81 1/4, 81 1/2, 81 3/4, 82, 82 1/4, 82 1/2, 82 3/4, 83, 83 1/4, 83 1/2, 83 3/4, 84, 84 1/4, 84 1/2, 84 3/4, 85, 85 1/4, 85 1/2, 85 3/4, 86, 86 1/4, 86 1/2, 86 3/4, 87, 87 1/4, 87 1/2, 87 3/4, 88, 88 1/4, 88 1/2, 88 3/4, 89, 89 1/4, 89 1/2, 89 3/4, 90, 90 1/4, 90 1/2, 90 3/4, 91, 91 1/4, 91 1/2, 91 3/4, 92, 92 1/4, 92 1/2, 92 3/4, 93, 93 1/4, 93 1/2, 93 3/4, 94, 94 1/4, 94 1/2, 94 3/4, 95, 95 1/4, 95 1/2, 95 3/4, 96, 96 1/4, 96 1/2, 96 3/4, 97, 97 1/4, 97 1/2, 97 3/4, 98, 98 1/4, 98 1/2, 98 3/4, 99, 99 1/4, 99 1/2, 99 3/4, 100, 100 1/4, 100 1/2, 100 3/4, 101, 101 1/4, 101 1/2, 101 3/4, 102, 102 1/4, 102 1/2, 102 3/4, 103, 103 1/4, 103 1/2, 103 3/4, 104, 104 1/4, 104 1/2, 104 3/4, 105, 105 1/4, 105 1/2, 105 3/4, 106, 106 1/4, 106 1/2, 106 3/4, 107, 107 1/4, 107 1/2, 107 3/4, 108, 108 1/4, 108 1/2, 108 3/4, 109, 109 1/4, 109 1/2, 109 3/4, 110, 110 1/4, 110 1/2, 110 3/4, 111, 111 1/4, 111 1/2, 111 3/4, 112, 112 1/4, 112 1/2, 112 3/4, 113, 113 1/4, 113 1/2, 113 3/4, 114, 114 1/4, 114 1/2, 114 3/4, 115, 115 1/4, 115 1/2, 115 3/4, 116, 116 1/4, 116 1/2, 116 3/4, 117, 117 1/4, 117 1/2, 117 3/4, 118, 118 1/4, 118 1/2, 118 3/4, 119, 119 1/4, 119 1/2, 119 3/4, 120, 120 1/4, 120 1/2, 120 3/4, 121, 121 1/4, 121 1/2, 121 3/4, 122, 122 1/4, 122 1/2, 122 3/4, 123, 123 1/4, 123 1/2, 123 3/4, 124, 124 1/4, 124 1/2, 124 3/4, 125, 125 1/4, 125 1/2, 125 3/4, 126, 126 1/4, 126 1/2, 126 3/4, 127, 127 1/4, 127 1/2, 127 3/4, 128, 128 1/4, 128 1/2, 128 3/4, 129, 129 1/4, 129 1/2, 129 3/4, 130, 130 1/4, 130 1/2, 130 3/4, 131, 131 1/4, 131 1/2, 131 3/4, 132, 132 1/4, 132 1/2, 132 3/4, 133, 133 1/4, 133 1/2, 133 3/4, 134, 134 1/4, 134 1/2, 134 3/4, 135, 135 1/4, 135 1/2, 135 3/4, 136, 136 1/4, 136 1/2, 136 3/4, 137, 137 1/4, 137 1/2, 137 3/4, 138, 138 1/4, 138 1/2, 138 3/4, 139, 139 1/4, 139 1/2, 139 3/4, 140, 140 1/4, 140 1/2, 140 3/4, 141, 141 1/4, 141 1/2, 141 3/4, 142, 142 1/4, 142 1/2, 142 3/4, 143, 143 1/4, 143 1/2, 143 3/4, 144, 144 1/4, 144 1/2, 144 3/4, 145, 145 1/4, 145 1/2, 145 3/4, 146, 146 1/4, 146 1/2, 146 3/4, 147, 147 1/4, 147 1/2, 147 3/4, 148, 148 1/4, 148 1/2, 148 3/4, 149, 149 1/4, 149 1/2, 149 3/4, 150, 150 1/4, 150 1/2, 150 3/4, 151, 151 1/4, 151 1/2, 151 3/4, 152, 152 1/4, 152 1/2, 152 3/4, 153, 153 1/4, 153 1/2, 153 3/4, 154, 154 1/4, 154 1/2, 154 3/4, 155, 155 1/4, 155 1/2, 155 3/4, 156, 156 1/4, 156 1/2, 156 3/4, 157, 157 1/4, 157 1/2, 157 3/4, 158, 158 1/4, 158 1/2, 158 3/4, 159, 159 1/4, 159 1/2, 159 3/4, 160, 160 1/4, 160 1/2, 160 3/4, 161, 161 1/4, 161 1/2, 161 3/4, 162, 162 1/4, 162 1/2, 162 3/4, 163, 163 1/4, 163 1/2, 163 3/4, 164, 164 1/4, 164 1/2, 164 3/4, 165, 165 1/4, 165 1/2, 165 3/4, 166, 166 1/4, 166 1/2, 166 3/4, 167, 167 1/4, 167 1/2, 167 3/4, 168, 168 1/4, 168 1/2, 168 3/4, 169, 169 1/4, 169 1/2, 169 3/4, 170, 170 1/4, 170 1/2, 170 3/4, 171, 171 1/4, 171 1/2, 171 3/4, 172, 172 1/4, 172 1/2, 172 3/4, 173, 173 1/4, 173 1/2, 173 3/4, 174, 174 1/4, 174 1/2, 174 3/4, 175, 175 1/4, 175 1/2, 175 3/4, 176, 176 1/4, 176 1/2, 176 3/4, 177, 177 1/4, 177 1/2, 177 3/4, 178, 178 1/4, 178 1/2, 178 3/4, 179, 179 1/4, 179 1/2, 179 3/4, 180, 180 1/4, 180 1/2, 180 3/4, 181, 181 1/4, 181 1/2, 181 3/4, 182, 182 1/4, 182 1/2, 182 3/4, 183, 183 1/4, 183 1/2, 183 3/4, 184, 184 1/4, 184 1/2, 184 3/4, 185, 185 1/4, 185 1/2, 185 3/4, 186, 186 1/4, 186 1/2, 186 3/4, 187, 187 1/4, 187 1/2, 187 3/4, 188, 188 1/4, 188 1/2, 188 3/4, 189, 189 1/4, 189 1/2, 189 3/4, 190, 190 1/4, 190 1/2, 190 3/4, 191, 191 1/4, 191 1/2, 191 3/4, 192, 192 1/4, 192 1/2, 192 3/4, 193, 193 1/4, 193 1/2, 193 3/4, 194, 194 1/4, 194 1/2, 194 3/4, 195, 195 1/4, 195 1/2, 195 3/4, 196, 196 1/4, 196 1/2, 196 3/4, 197, 197 1/4, 197 1/2, 197 3/4, 198, 198 1/4, 198 1/2, 198 3/4, 199, 199 1/4, 199 1/2, 199 3/4, 200, 200 1/4, 200 1/2, 200 3/4, 201, 201 1/4, 201 1/2, 201 3/4, 202, 202 1/4, 202 1/2, 202 3/4, 203, 203 1/4, 203 1/2, 203 3/4, 204, 204 1/4, 204 1/2, 204 3/4, 205, 205 1/4, 205 1/2, 205 3/4, 206, 206 1/4, 206 1/2, 206 3/4, 207, 207 1/4, 207 1/2, 207 3/4, 208, 208 1/4, 208 1/2, 208 3/4, 209, 209 1/4, 209 1/2, 209 3/4, 210, 210 1/4, 210 1/2, 210 3/4, 211, 211 1/4, 211 1/2, 211 3/4, 212, 212 1/4, 212 1/2, 212 3/4, 213, 213 1/4, 213 1/2, 213 3/4, 214, 214 1/4, 214 1/2, 214 3/4, 215, 215 1/4, 215 1/2, 215 3/4, 216, 216 1/4, 216 1/2, 216 3/4, 217, 217 1/4, 217 1/2, 217 3/4, 218, 218 1/4, 218 1/2, 218 3/4, 219, 219 1/4, 219 1/2, 219 3/4, 220, 220 1/4, 220 1/2, 220 3/4, 221, 221 1/4, 221 1/2, 221 3/4, 222, 222 1/4, 222 1/2, 222 3/4, 223, 223 1/4, 223 1/2, 223 3/4, 224, 224 1/4, 224 1/2, 224 3/4, 225, 225 1/4, 225 1/2, 225 3/4, 226, 226 1/4, 226 1/2, 226 3/4, 227, 227 1/4, 227 1/2, 227 3/4, 228, 228 1/4, 228 1/2, 228 3/4, 229, 229 1/4, 229 1/2, 229 3/4, 230, 230 1/4, 230 1/2, 230 3/4, 231, 231 1/4, 231 1/2, 231 3/4, 232, 232 1/4, 232 1/2, 232 3/4, 233, 233 1/4, 233 1/2, 233 3/4, 234, 234 1/4, 234 1/2, 234 3/4, 235, 235 1/4, 235 1/2, 235 3/4, 236, 236 1/4, 236 1/2, 236 3/4, 237, 237 1/4, 237 1/2, 237 3/4, 238, 238 1/4, 238 1/2, 238 3/4, 239, 239 1/4, 239 1/2, 239 3/4, 240, 240 1/4, 240 1/2, 240 3/4, 241, 241 1/4, 241 1/2, 241 3/4, 242, 242 1/4, 242 1/2, 242 3/4, 243, 243 1/4, 243 1/2, 243 3/4, 244, 244 1/4, 244 1/2, 244 3/4, 245, 245 1/4, 245 1/2, 245 3/4, 246, 246 1/4, 246 1/2, 246 3/4, 247, 247 1/4, 247 1/2, 247 3/4, 248, 248 1/4, 248 1/2, 248 3/4, 249, 249 1/4, 249 1/2, 249 3/4, 250, 250 1/4, 250 1/2, 250 3/4, 251, 251 1/4, 251 1/2, 251 3/4, 252, 252 1/4, 252 1/2, 252 3/4, 253, 253 1/4, 253 1/2, 253 3/4, 254, 254 1/4, 254 1/2, 254 3/4, 255, 255 1/4, 255 1/2, 255 3/4, 256, 256 1/4, 256 1/2, 256 3/4, 257, 257 1/4, 257 1/2, 257 3/4, 258, 258 1/4, 258 1/2, 258 3/4, 259, 259 1/4, 259 1/2, 259 3/4, 260, 260 1/4, 260 1/2, 260 3/4, 261, 261 1/4, 261 1/2, 261 3/4, 262, 262 1/4, 262 1/2, 262 3/4, 263, 263 1/4, 263 1/2, 263 3/4, 264, 264 1/4, 264 1/2, 264 3/4, 265, 265 1/4, 265 1/2, 265 3/4, 266, 266 1/4, 266 1/2, 266 3/4, 267, 267 1/4, 267 1/2, 267 3/4, 268, 268 1/4, 268 1/2, 268 3/4, 269, 269 1/4, 269 1/2, 269 3/4, 270, 270 1/4, 270 1/2, 270 3/4, 271, 271 1/4, 271 1/2, 271 3/4, 272, 272 1/4, 272 1/2, 272 3/4, 273, 273 1/4, 273 1/2, 273 3/4, 274, 274 1/4, 274 1/2, 274 3/4, 275, 275 1/4, 275 1/2, 275 3/4, 276, 276 1/4, 276 1/2, 276 3/4, 277, 277 1/4, 277 1/2, 277 3/4, 278, 278 1/4, 278 1/2, 278 3/4, 279, 279 1/4, 279 1/2, 279 3/4, 280, 280 1/4, 280 1/2, 280 3/4, 281, 281 1/4, 281 1/2, 281 3/4, 282, 282 1/4, 282 1/2, 282 3/4, 283, 283 1/4, 283 1/2, 283 3/4, 284, 284 1/4, 284 1/2, 284 3/4, 285, 285 1/4, 285 1/2, 285 3/4, 286, 286 1/4, 286 1/2, 286 3/4, 287, 287 1/4, 287 1/2, 287 3/4, 288, 288 1/4, 288 1/2, 288 3/4, 289, 289 1/4, 289 1/2, 289 3/4, 290, 290 1/4, 290 1/2, 290 3/4, 291, 291 1/4, 291 1/2, 291 3/4, 292, 292 1/4, 292 1/2, 292 3/4, 293, 293 1/4, 293 1/2, 293 3/4, 294, 294 1/4, 294 1/2, 294 3/4, 295, 295 1/4, 295 1/2, 295 3/4, 296, 296 1/4, 296 1/2, 296 3/4, 297, 297 1/4, 297 1/2, 297 3/4, 298, 298 1/4, 298 1/2, 298 3/4, 299, 299 1/4, 299 1/2, 299 3/4, 300, 300 1/4, 300 1/2, 300 3/4, 301, 301 1/4, 301 1/2, 301 3/4, 302, 302 1/4, 302 1/2, 302 3/4, 303, 303 1/4, 303 1/2, 303 3/4, 304, 304 1/4, 304 1/2, 304 3/4, 305, 305 1/4, 305 1/2, 305 3/4, 306, 306 1/4, 306 1/2, 306 3/4, 307, 307 1/4, 307 1/2, 307 3/4, 308, 308 1/4, 308 1/2, 308 3/4, 309, 309 1/4, 309 1/2, 309 3/4, 310, 310 1/4, 310 1/2, 310 3/4, 311, 311 1/4, 311 1/2, 311 3/4, 312, 312 1/4, 312 1/2, 312 3/4, 313, 313 1/4, 313 1/2, 313 3/4, 314, 314 1/4, 314 1/2, 314 3/4, 315, 315 1/4, 315 1/2, 315 3/4, 316, 316 1/4, 316 1/2, 316 3/4, 317, 317 1/4, 317 1/2, 317 3/4, 318, 318 1/4, 318 1/2, 318 3/4, 319, 319 1/4, 319 1/2, 319 3/4, 320, 320 1/4, 320 1/2, 320 3/4, 321, 321 1/4, 321 1/2, 321 3/4, 322, 322 1/4, 322 1/2, 322 3/4, 323, 323 1/4, 323 1/2, 323 3/4, 324, 324 1/4, 324 1/2, 324 3/4, 325, 325 1/4, 325 1/2, 325 3/4, 326, 326 1/4, 326 1/2, 326 3/4, 327, 327 1/4, 327 1/2, 327 3/4, 328, 328 1/4, 328 1/2, 328 3/4, 329, 329 1/4, 329 1/2, 329 3/4, 330, 330 1/4, 330 1/2, 330 3/4, 331, 331 1/4, 331 1/2, 331 3/4, 332, 332 1/4, 332 1/2, 332 3/4, 333, 333 1/4, 333 1/2, 333 3/4, 334, 334 1/4, 334 1/2, 334 3/4, 335, 335 1/4, 335 1/2, 335 3/4, 336, 336 1/4, 336 1/2, 336 3/4, 337, 337 1/4, 337 1/2, 337 3/4, 338, 338 1/4, 338 1/2, 338 3/4, 339, 339 1/4, 339 1/2, 339 3/4, 340, 340 1/4, 340 1/2, 340 3/4, 341, 341 1/4, 341 1/2, 341 3/4, 342, 342 1/4, 342 1/2, 342 3/4, 343, 343 1/4, 343 1/2, 343 3/4, 344, 344 1/4, 344 1/2, 344 3/4, 345, 345 1/4, 345 1/2, 345 3/4, 346, 346 1/4, 346 1/2, 346 3/4, 347, 347 1/4, 347 1/2, 347 3/4, 348, 348 1/4, 348 1/2, 348 3/4, 349, 349 1/4, 349 1/2, 349 3/4, 350, 350 1/4, 350 1/2, 350 3/4, 351, 351 1/4, 351 1/2, 351 3/4, 352, 352 1/4, 352 1/2, 352 3/4, 353, 353 1/4, 353 1/2, 353 3/4, 354, 354 1/4, 354 1/2, 354 3/4, 355, 355 1/4, 355 1/2, 355 3/4, 356, 356 1/4, 356 1/2, 356 3/4, 357, 357 1/4, 357 1/2, 357 3/4, 358, 358 1/4, 358 1/2, 358 3/4, 359, 359 1/4, 359 1/2, 359 3/4, 360, 360 1/4, 360 1/2, 360 3/4, 361, 361 1/4, 361 1/2, 361 3/4, 362, 362 1/4, 362 1/2, 362 3/4, 363, 363 1/4, 363 1/2, 363 3/4, 364, 364 1/4, 364 1/2, 364 3/4, 365, 365 1/4, 365 1/2, 365 3/4, 366, 366 1/4, 366 1/2, 366 3/4, 367, 367 1/4, 367 1/2, 367 3/4, 368, 368 1/4, 368 1/2, 368 3/4, 369, 369 1/4, 369 1/2, 369 3/4, 3								

SYM	COMPONENT	VALUE	TOL
A1	NEXUS RESEARCH LAB CDA-12A		
C1	SPRAGE 118P1039282	.01MF	10%
R1	MEPCO RN65C2002C	20K	.25%
R2	MEPCO RN65C2002C	20K	.25%
R3	MEPCO RN65C2002C	20K	.25%
R4	MEPCO RN65B6811F	6.81K	1%
R5	BOURNS 200L-2-104	100K	10%
R6	MEPCO RN65C1001F	10K	1%
R7	BOURNS 200L-2-103	10K	10%
PB1	RATHEON PLUG IN BOARD M681		
TPI	UCINITE TEST JACK 119437		



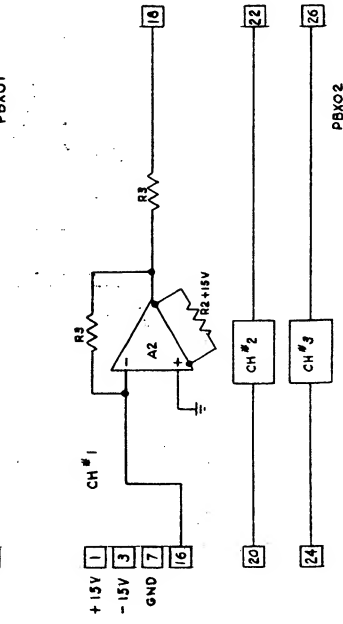
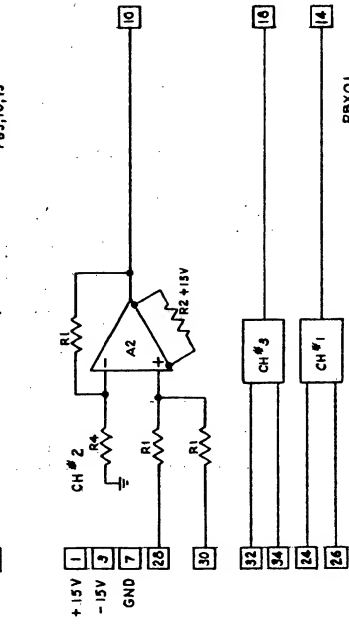
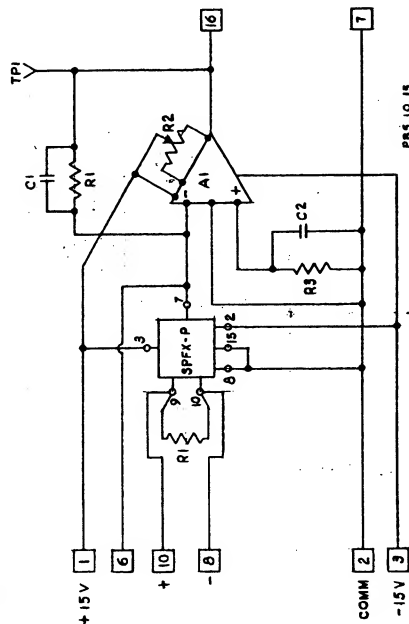
PARTS LIST

ITEM NO.	QTY	CODE	DESCRIPTION	PART NO. OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL	MATL SPEC	DWG NO.
1	1		OPERATIONAL AMPLIFIER					
2	1		RESISTOR					
3	1		RESISTOR					
4	1		RESISTOR					
5	1		RESISTOR					
6	1		RESISTOR					
7	1		RESISTOR					
8	1		RESISTOR					
9	1		RESISTOR					
10	1		RESISTOR					
11	1		CAPACITOR					
12	1		PLUG IN BOARD					
13	1		TEST JACK					
<div> <div> U.S. ARMY NITELAB LABORATORIES DATA RETRIEVAL SYSTEM SUMMING AMPLIFIER PB1G </div> <div> DATE 3 OCT 74 PREPARED BY CHECKED BY ENGINEER APPROVAL DESIGN ACTIVITY APPROVAL OTHER </div> </div>								
<div> SIZE CODE IDENT NO DRAWING NO D 81337 11-1-2509 </div>								
<div> SCALE UNIT WT. SHEET OF </div>								

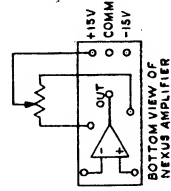
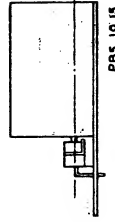
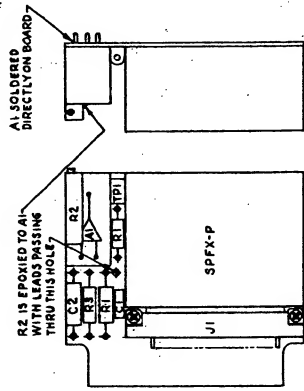
NOTES:

SYM	COMPONENT	VALUE	TOL
CR1	IN4538		
CR2	IN4538		
CR3	IN4538		
CR4	IN4538		
CR5	IN4538		
A1	NEUS RESEARCH LABS FSL-1E		
A2	NEUS RESEARCH LABS FSL-1E		
R1		4.99K	1%
R2		470	1%
R3		470	1%
R4		4.99K	1%
R5		4.99K	1%
R6		10K	1%
R7		10K	1%
R8		10K	1%
R9		10K	1%
R10		100K	10%
R11		100K	10%
R12		100K	10%
R13		20K	5%
R14		20K	5%
R15		20K	5%
R16		20K	5%
R17		20K	5%
R18		20K	5%
R19		20K	5%
R20		20K	5%
R21		20K	5%
R22		20K	5%
R23		20K	5%
R24		20K	5%
R25		20K	5%
R26		20K	5%
R27		20K	5%
R28		20K	5%
R29		20K	5%
R30		20K	5%
R31		20K	5%
R32		20K	5%
R33		20K	5%
R34		20K	5%
R35		20K	5%
R36		20K	5%
R37		20K	5%
R38		20K	5%
R39		20K	5%
R40		20K	5%
R41		20K	5%
R42		20K	5%
R43		20K	5%
R44		20K	5%
R45		20K	5%
R46		20K	5%
R47		20K	5%
R48		20K	5%
R49		20K	5%
R50		20K	5%
R51		20K	5%
R52		20K	5%
R53		20K	5%
R54		20K	5%
R55		20K	5%
R56		20K	5%
R57		20K	5%
R58		20K	5%
R59		20K	5%
R60		20K	5%
R61		20K	5%
R62		20K	5%
R63		20K	5%
R64		20K	5%
R65		20K	5%
R66		20K	5%
R67		20K	5%
R68		20K	5%
R69		20K	5%
R70		20K	5%
R71		20K	5%
R72		20K	5%
R73		20K	5%
R74		20K	5%
R75		20K	5%
R76		20K	5%
R77		20K	5%
R78		20K	5%
R79		20K	5%
R80		20K	5%
R81		20K	5%
R82		20K	5%
R83		20K	5%
R84		20K	5%
R85		20K	5%
R86		20K	5%
R87		20K	5%
R88		20K	5%
R89		20K	5%
R90		20K	5%
R91		20K	5%
R92		20K	5%
R93		20K	5%
R94		20K	5%
R95		20K	5%
R96		20K	5%
R97		20K	5%
R98		20K	5%
R99		20K	5%
R100		20K	5%
R101		20K	5%
R102		20K	5%
R103		20K	5%
R104		20K	5%
R105		20K	5%
R106		20K	5%
R107		20K	5%
R108		20K	5%
R109		20K	5%
R110		20K	5%
R111		20K	5%
R112		20K	5%
R113		20K	5%
R114		20K	5%
R115		20K	5%
R116		20K	5%
R117		20K	5%
R118		20K	5%
R119		20K	5%
R120		20K	5%
R121		20K	5%
R122		20K	5%
R123		20K	5%
R124		20K	5%
R125		20K	5%
R126		20K	5%
R127		20K	5%
R128		20K	5%
R129		20K	5%
R130		20K	5%
R131		20K	5%
R132		20K	5%
R133		20K	5%
R134		20K	5%
R135		20K	5%
R136		20K	5%
R137		20K	5%
R138		20K	5%
R139		20K	5%
R140		20K	5%
R141		20K	5%
R142		20K	5%
R143		20K	5%
R144		20K	5%
R145		20K	5%
R146		20K	5%
R147		20K	5%
R148		20K	5%
R149		20K	5%
R150		20K	5%
R151		20K	5%
R152		20K	5%
R153		20K	5%
R154		20K	5%
R155		20K	5%
R156		20K	5%
R157		20K	5%
R158		20K	5%
R159		20K	5%
R160		20K	5%
R161		20K	5%
R162		20K	5%
R163		20K	5%
R164		20K	5%
R165		20K	5%
R166		20K	5%
R167		20K	5%
R168		20K	5%
R169		20K	5%
R170		20K	5%
R171		20K	5%
R172		20K	5%
R173		20K	5%
R174		20K	5%
R175		20K	5%
R176		20K	5%
R177		20K	5%
R178		20K	5%
R179		20K	5%
R180		20K	5%
R181		20K	5%
R182		20K	5%
R183		20K	5%
R184		20K	5%
R185		20K	5%
R186		20K	5%
R187		20K	5%
R188		20K	5%
R189		20K	5%
R190		20K	5%
R191		20K	5%
R192		20K	5%
R193		20K	5%
R194		20K	5%
R195		20K	5%
R196		20K	5%
R197		20K	5%
R198		20K	5%
R199		20K	5%
R200		20K	5%
R201		20K	5%
R202		20K	5%
R203		20K	5%
R204		20K	5%
R205		20K	5%
R206		20K	5%
R207		20K	5%
R208		20K	5%
R209		20K	5%
R210		20K	5%
R211		20K	5%
R212		20K	5%
R213		20K	5%
R214		20K	5%
R215		20K	5%
R216		20K	5%
R217		20K	5%
R218		20K	5%
R219		20K	5%
R220		20K	5%
R221		20K	5%
R222		20K	5%
R223		20K	5%
R224		20K	5%
R225		20K	5%
R226		20K	5%
R227		20K	5%
R228		20K	5%
R229		20K	5%
R230		20K	5%
R231		20K	5%
R232		20K	5%
R233		20K	5%
R234		20K	5%
R235		20K	5%
R236		20K	5%
R237		20K	5%
R238		20K	5%
R239		20K	5%
R240		20K	5%
R241		20K	5%
R242		20K	5%
R243		20K	5%
R244		20K	5%
R245		20K	5%
R246		20K	5%
R247		20K	5%
R248		20K	5%
R249		20K	5%
R250		20K	5%
R251		20K	5%
R252		20K	5%
R253		20K	5%
R254		20K	5%
R255		20K	5%
R256		20K	5%
R257		20K	5%
R258		20K	5%
R259		20K	5%
R260		20K	5%
R261		20K	5%
R262		20K	5%
R263		20K	5%
R264		20K	5%
R265		20K	5%
R266		20K	5%
R267		20K	5%
R268		20K	5%
R269		20K	5%
R270		20K	5%
R271		20K	5%
R272		20K	5%
R273		20K	5%
R274		20K	5%
R275		20K	5%
R276		20K	5%
R277		20K	5%
R278		20K	5%
R279		20K	5%
R280		20K	5%
R281		20K	5%
R282		20K	5%
R283		20K	5%
R284		20K	5%
R285		20K	5%
R286		20K	5%
R287		20K	5%
R288		20K	5%
R289		20K	5%
R290		20K	5%
R291		20K	5%
R292		20K	5%
R293		20K	5%
R294		20K	5%
R295		20K	5%
R296		20K	5%
R297		20K	5%
R298		20K	5%
R299		20K	5%
R300		20K	5%
R301		20K	5%
R302		20K	5%
R303		20K	5%
R304		20K	5%
R305		20K	5%
R306		20K	5%
R307		20K	5%
R308		20K	5%
R309		20K	5%
R310		20K	5%
R311		20K	5%
R312		20K	5%
R313		20K	5%
R314		20K	5%
R315		20K	5%
R316		20K	5%
R317		20K	5%
R318		20K	5%
R319		20K	5%
R320		20K	5%
R321		20K	5%
R322		20K	5%
R323		20K	5%
R324		20K	5%
R325		20K	5%
R326		20K	5%
R327		20K	5%
R328		20K	5%
R329		20K	5%
R330		20K	5%
R331		20K	5%
R332		20K	5%
R333		20K	5%
R334		20K	5%
R335		20K	5%
R336		20K	5%
R337		20K	5%
R338		20K	5%
R339		20K	5%
R340		20K	5%
R341		20K	5%
R342		20K	5%
R343		20K	5%
R344		20K	5%
R345		20K	5%
R346		20K	5%
R347		20K	5%
R348		20K	5%
R349		20K	5%
R350		20K	5%
R351		20K	5%
R352		20K	5%
R353		20K	5%
R354		20K	5%
R355		20K	5%
R356		20K	5%
R357		20K	5%
R358		20K	5%
R359		20K	5%
R360		20K	5%
R361		20K	5%
R362		20K	5%
R363		20K	5%
R364		20K	5%
R365		20K	5%
R366		20K	5%
R367		20K	5%
R368		20K	5%
R369		20K	5%
R370		20K	5%
R371		20K	5%
R372		20K	5%
R373		20K	5%
R374		20K	5%
R375		20K	5%
R376		20K	5%
R377		20K	5%
R378		20K	5%
R379		20K	5%
R380			

NOTES:



SYM	COMPONENT	VALUE	TOL	QTY
A1	NEXUS RESEARCH LAB COAXIAL			1
A2	TELETYPE PHILBRICK 88-10A			4
SPFX-P	TRANSISTOR	18PF 10%		1
C1	ELMENDO DM10-180J	0.1MF 10%		1
C2	SPRAGUE 118P103922	20K 10%		1
R1	WEPKO RNSC200SC	100K 10%		7
R2	BOURNS 200L-2-104	10K 10%		7
R3	WEPKO RNSC1002F	10K 10%		7
R4	WEPKO RNSC1002F	10K 10%		7
R5	RAYTHEON PLUG IN BOARD M881	10K 10%		7
TPI	UCNITE TEST JACK 119437			1
J1	METHODE 3DR-5138			1

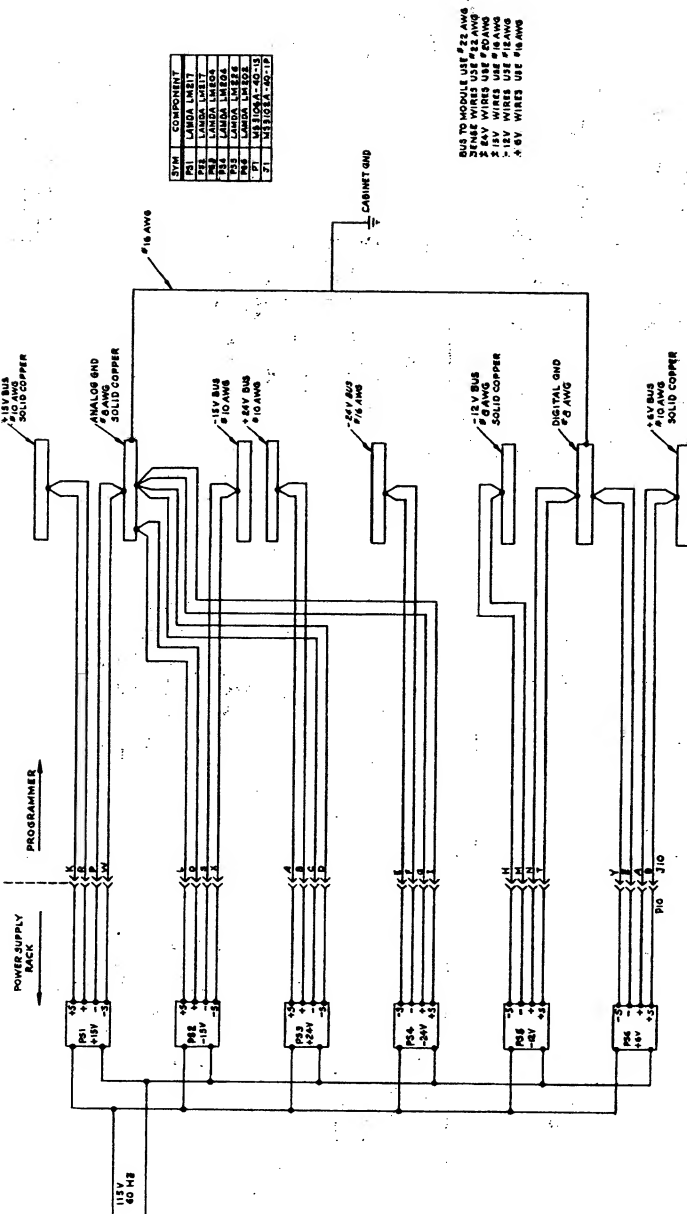


PARTS LIST

ITEM NO.	QTY	CODE	DESCRIPTION	PART NO. OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL	UNIT	QTY	DWG NO.
1	1		SPFX-P						
2	4		A2						
3	1		C1						
4	1		C2						
5	7		R1						
6	7		R2						
7	7		R3						
8	7		R4						
9	1		TPI						
10	1		J1						

U.S. ARMY MATER LABORATORIES MATER. NO. 11-1-2511									
DATE 9 OCT 74									
PREPARED BY									
CHECKED BY									
ENGINEER									
APPROVAL DESIGN ACTIVITY									
SIZE CODE (DWT NO) DRAWING NO.									
D 81337									
SCALE									
UNIT WT.									
SHEET 02									

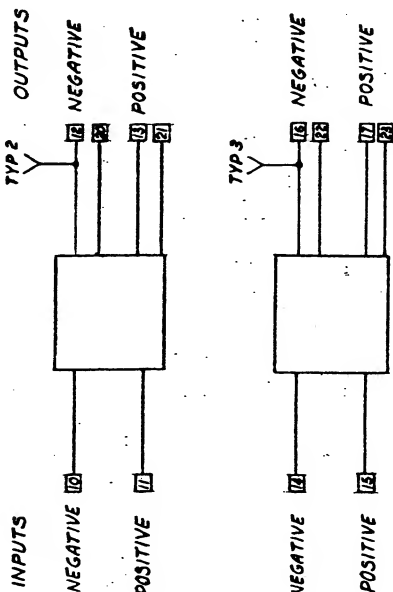
NOTES:



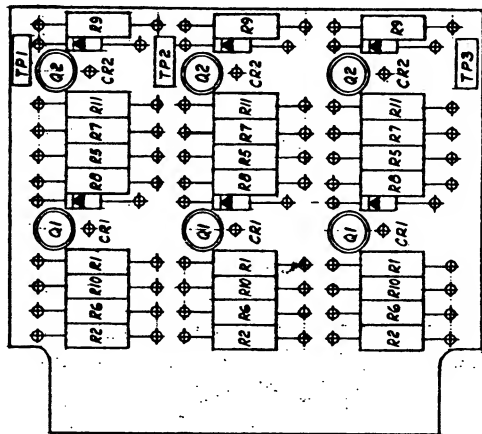
SYM	COMPONENT
P1	LANCIA UNIT
P2	LANCIA UNIT
P3	LANCIA UNIT
P4	LANCIA UNIT
P5	LANCIA UNIT
P6	LANCIA UNIT
1	115V 40 Hz
2	115V 40 Hz

BUS TO MODULE USE #16 AWG
 SENSE WIRES USE #22 AWG
 24V WIRES USE #10 AWG
 12V WIRES USE #10 AWG
 5V WIRES USE #16 AWG

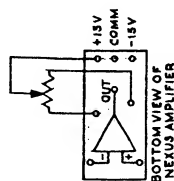
ITEM	QTY	CODE	DESCRIPTION	DATE	BY	CHKD	DATE	BY	CHKD
PARTS LIST									
U.S. ARMY MATERIEL LABORATORIES 11-1-2513 DATA RETRIEVAL SYSTEM POWER SUPPLY CONNECTIONS									
DATE: 9 OCT 74 CHECKED: [] PREPARED: [] APPROVED: [] 81337									



SYM	COMPONENT	VALUE	TOL
CRI	INT03A		
CR2	INT03A		
Q1	8N219		
Q2	8N219		
R1	RC20G103W	10K	5%
R2	RC20G222W	2.2K	5%
R4	RC20G222W	2.2K	5%
R5	RC20G103W	10K	5%
R6	RC20G222W	2.2K	5%
R7	RC20G222W	2.2K	5%
R8	RC20G222W	2.2K	5%
R9	RC20G408W	6.8K	5%
P1	RC20G408W	6.8K	5%
P2	8AY16W PLUG IN BOARD W/1		
R10	RC20G472W	4.7K	5%
R11	RC20G472W	4.7K	5%
TP1	UC19437 TEST JACK		
TP2	UC19437 TEST JACK		
TP3	UC19437 TEST JACK		

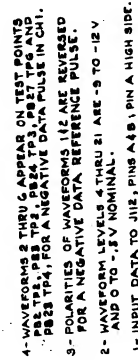


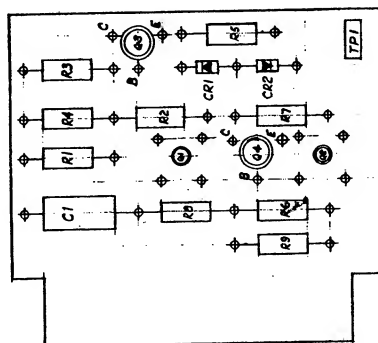
ITEM NO.	QTY REQD	CODE IDENT	PART NO. OR IDENTIFYING NO.	DESCRIPTION	MATERIAL	DATE SPEC	DWG NO.
PARTS LIST							
VALVES OTHER THAN SERVICE VALVES ARE IN SECTIONS OF THE VALVE BODY DETAIL DRAWING				U.S. ARMY MATRICE LABORATORIES MATRICE, NEW YORK 10010			
				DATA RETRIEVAL SYSTEM PEAK MEMORY SWITCH DRIVER P828			
				DATE	9 OCT 74		
				DESIGNED BY	E. M. LARSEN		
				CHECKED BY	E. M. LARSEN		
				ENGINEER	E. M. LARSEN		
				APPROVAL	E. M. LARSEN		
				DESIGN ACTIVITY	E. M. LARSEN		
				APPROVAL OTHER	E. M. LARSEN		
				MATERIAL	SIZE CODE (DWT) NO. DRAWING NO. D 81337 11-1-2514		
				SCALE	UNIT WT. TOLERANCE		
				NEXT ARMY APPLICATION			



ITEM NO.	QTY USED	CODE IDENT	PART NO. OR IDENTIFYING NO.	NUMERICAL CODE OR DESCRIPTION	MATERIAL	NATL SPEC.	DWG NO.
PARTS LIST							
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES WIRE AND METAL BOLDS INCLUDES			U.S. ARMY MATCO LABORATORIES MATCO, MODEL 31790				
TOLERANCES			DATE 9 OCT 74				
FRACTIONS *			PREPARED GSW-M				
DECIMALS *			CHECKED F.M.				
2 PLACE DIMS *			APPROVED ENGINEER				
3 PLACE DIMS *			APPROVAL DESIGN ACTIVITY				
MATERIAL			SIZE CODE SHORT NO DRAWING NO				
			D 81337				
			APPROVAL OTHER				
			Said P. Parker				
			11-1-2515				
NATL ASSY			DRAWING NO				
NATL ASSY			PART NO.				
NATL ASSY			QTY USED				
NATL ASSY			CODE IDENT				
NATL ASSY			PART NO. OR IDENTIFYING NO.				
NATL ASSY			NUMERICAL CODE OR DESCRIPTION				
NATL ASSY			MATERIAL				
NATL ASSY			NATL SPEC.				
NATL ASSY			DWG NO.				

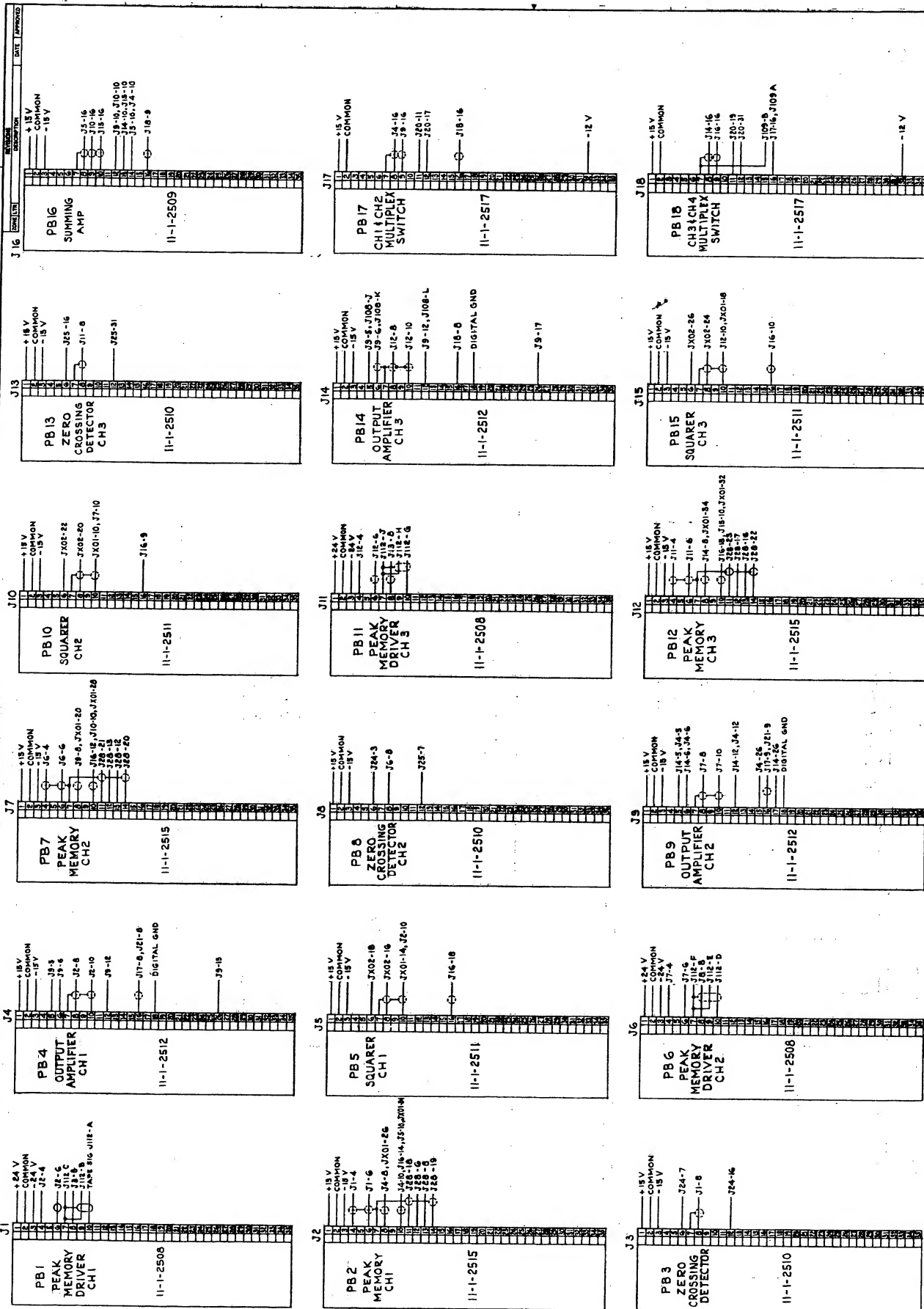
NOTES:

[illegible]

[illegible]

ITEM	QTY	UNIT	DATE CODE	UNIT PRICE	TOTAL PRICE	UNIT PRICE	DATE CODE	UNIT PRICE	TOTAL PRICE
PARTS LIST									
U.S. ARMY NAVY LABORATORIES WASHINGTON, D.C. 20315									
DATA RETRIEVAL SYSTEM MULTIPLEX SWITCH PB1T, PB18									
1. 81337 11-1-2617									

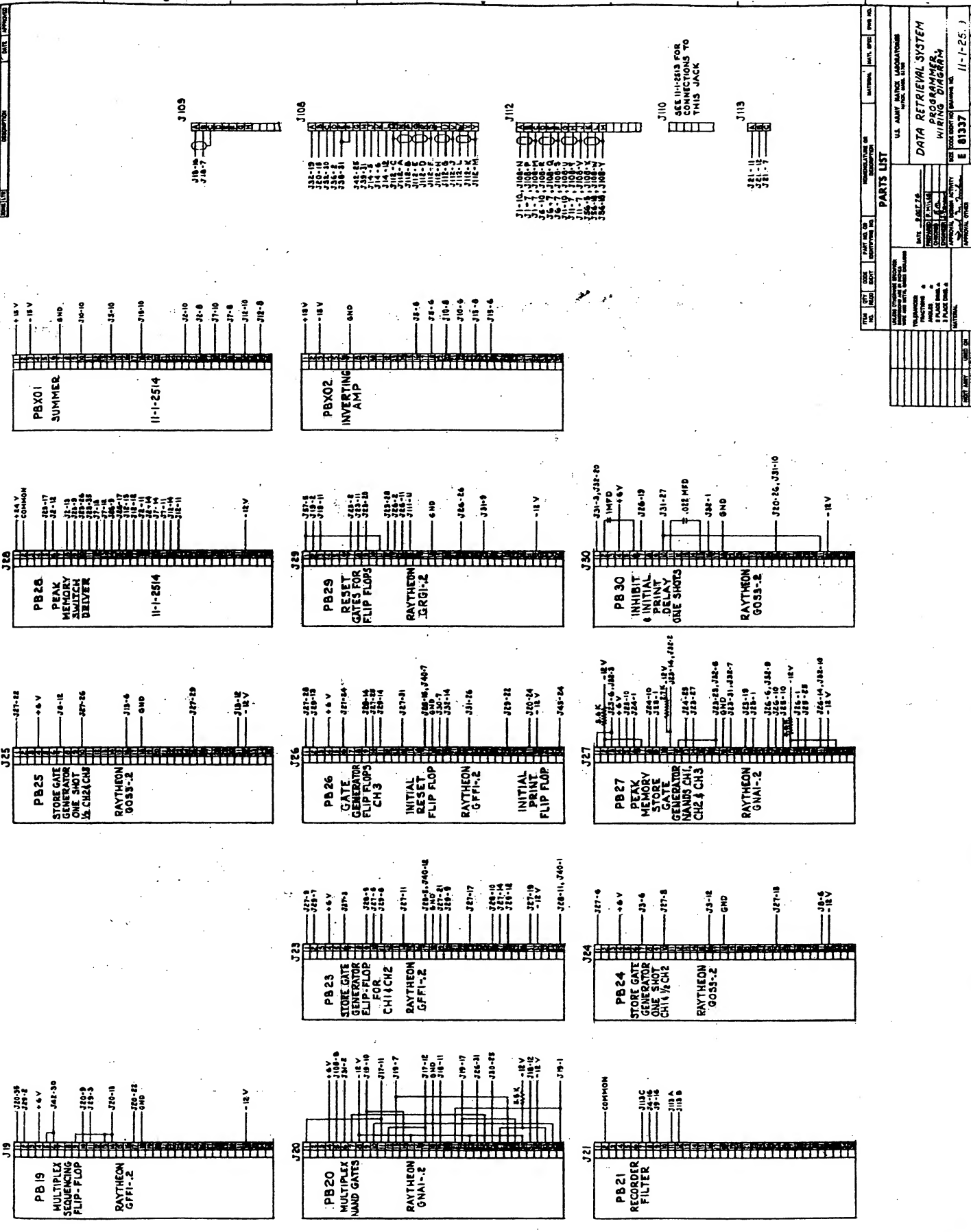
NOTES:

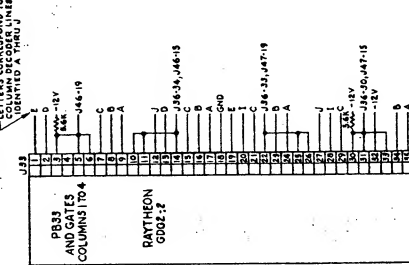
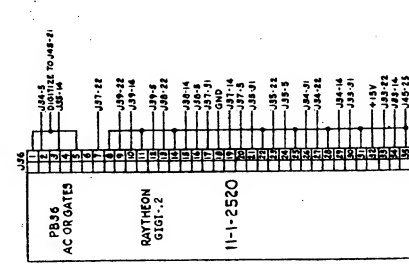
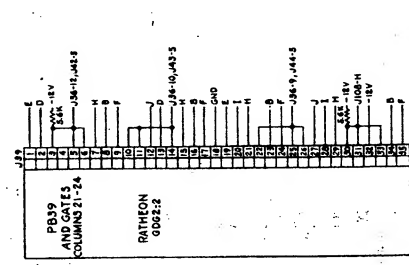
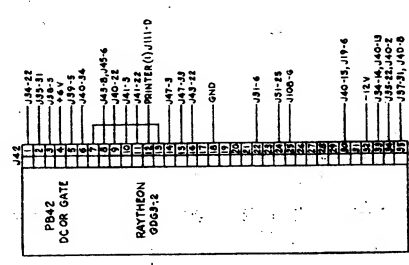
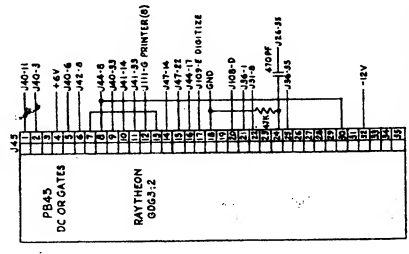
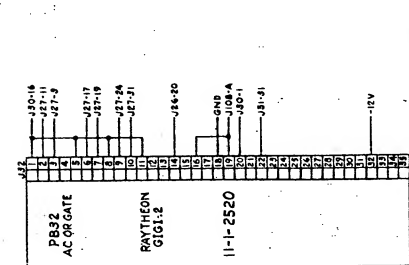
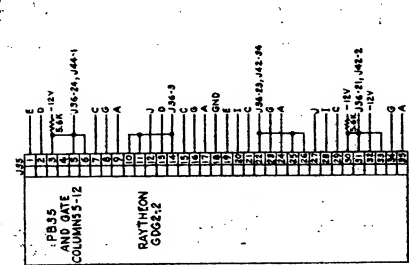
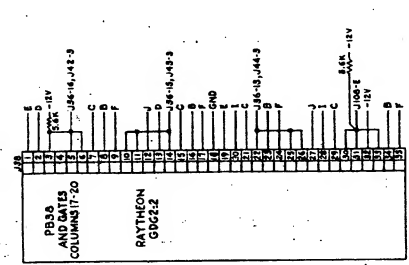
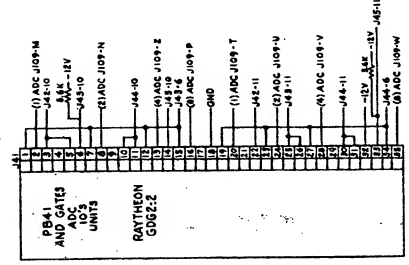
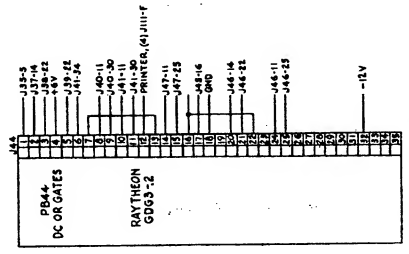
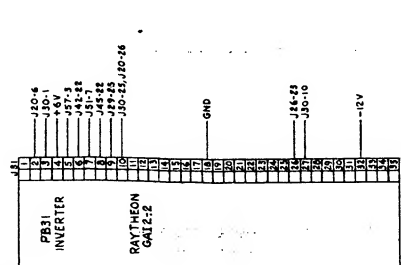
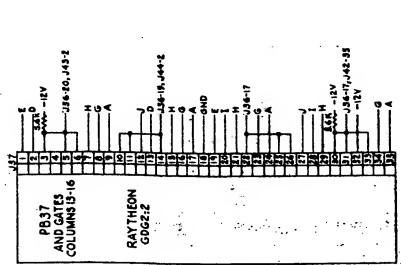
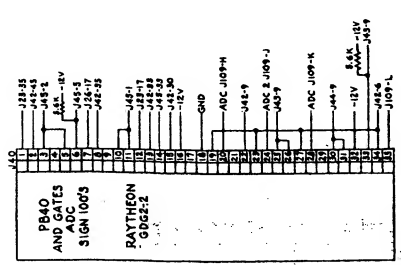
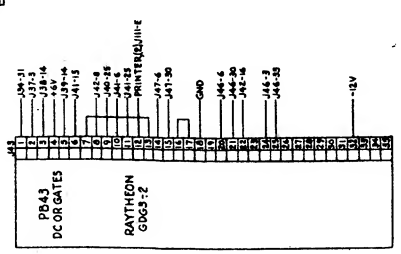


PARTS LIST		U.S. ARMY MATERIEL LABORATORIES	
ITEM NO.	DESCRIPTION	QUANTITY	REMARKS
1	11-1-2508	1	
2	11-1-2511	1	
3	11-1-2512	1	
4	11-1-2515	1	
5	11-1-2517	1	
6	11-1-2519	1	

DATE: 8 OCT 74
 PREPARED BY: [Signature]
 CHECKED BY: [Signature]
 APPROVED BY: [Signature]
 U.S. ARMY MATERIEL LABORATORIES
 DATA RETRIEVAL SYSTEM
 PROGRAMMER
 WIRING DIAGRAM
 11-1-2519

NOTES:



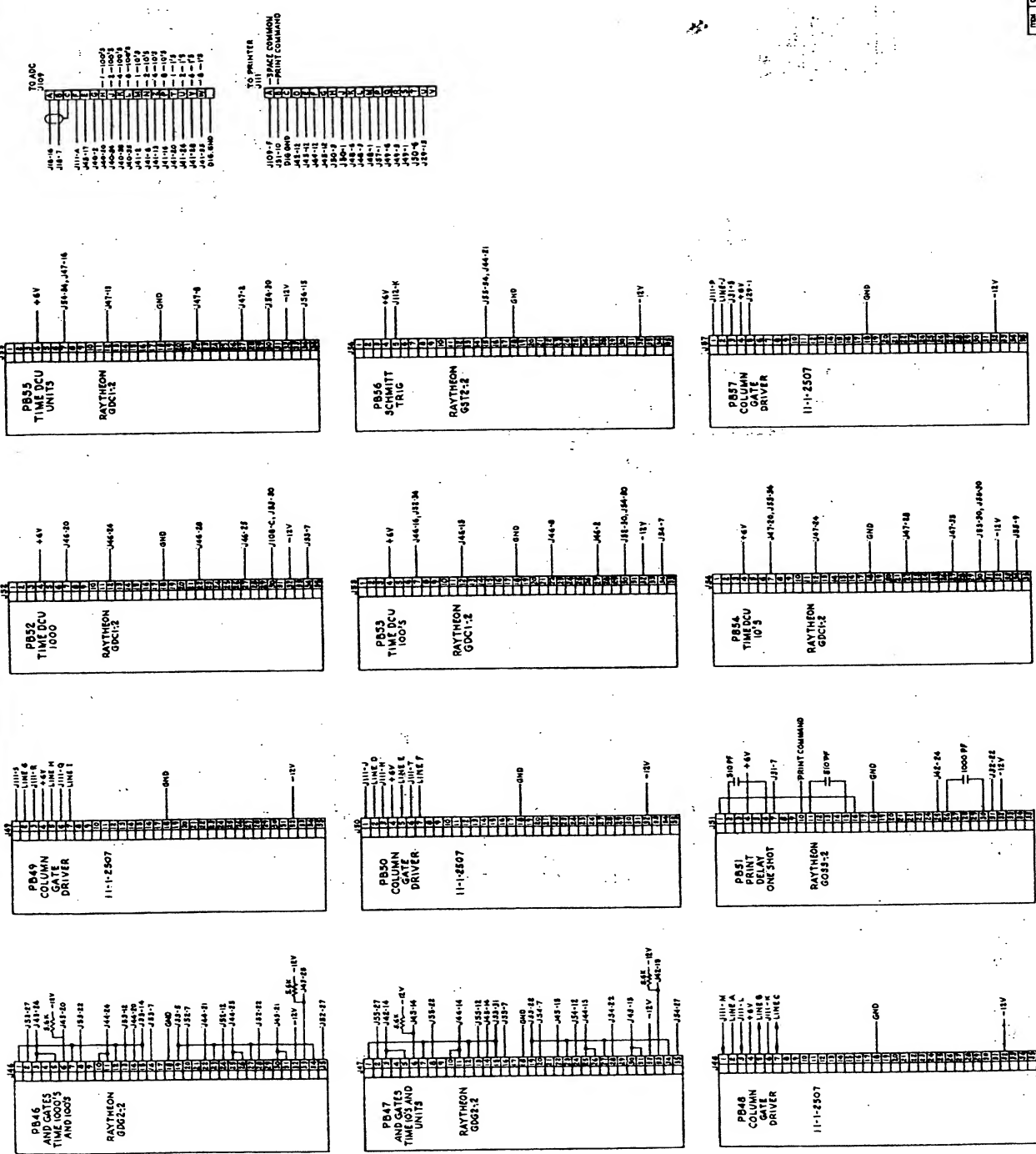


LETTERS CORRESPOND TO
COLUMN DECODER LINES
IDENTIFIED ABOVE.

NOTES:

[illegible]

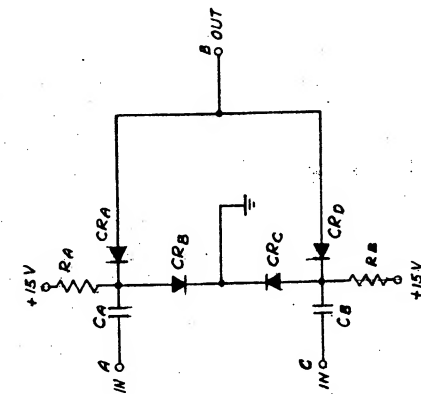
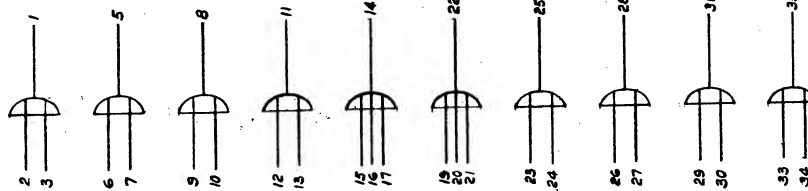
NOTES:



PARTS LIST		U.S. ARMY RESEARCH LABORATORIES	
ITEM NO.	DESCRIPTION	QUANTITY	UNIT PRICE
<p>DATA RETRIEVAL SYSTEM PROGRAMMER WIRING DIAGRAM</p> <p>DATE: 3-6-74 DESIGNED BY: [blank] CHECKED BY: [blank] APPROVED BY: [blank] E 81337 11-1-25-1</p>			

NOTES:

- THIS BOARD IS A RAYTHEON GIGI-2 WITH THE DIODES REVERSED AND RA & RB REPLACED WITH 47K RESISTORS.



SYM	COMPONENT	VALUE	TOL
CA	CAPACITOR	390PF	±10%
CB	CAPACITOR	390PF	±10%
CRA	RAYTHEON PEC503050		
CRB	RAYTHEON PEC503050		
CRD	RAYTHEON PEC503050		
RA	RC206F473J	47K	5%
RB	RC206F473J	47K	5%

REVISIONS		DATE		APPROVED	
DESCRIPTION					
DATE		LTH			
ITEM NO.		QTY		CODE	
NO.		REQD		IDENT	
PART NO. OR IDENTIFYING NO.		NOMENCLATURE OR DESCRIPTION		MATERIAL	
DATE		9 OCT 74		MATERIAL SPEC	
PREPARED		F. H. 1125		DWG NO.	
CHECKED		F. H. 1125			
ENGINEER		F. H. 1125			
APPROVAL		DESIGN ACTIVITY			
APPROVAL OTHER		SCALE		UNIT WT.	
NEXT ARMY APPLICATION		USED ON		SHEET	
				OF	

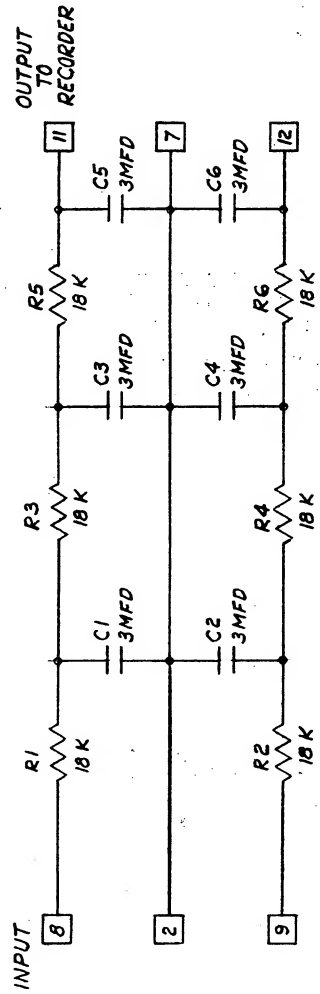
U.S. ARMY MATCOX LABORATORIES
MATCOX BANGS 10760

DATA RETRIEVAL SYSTEM
ACOR GATE NEGATIVE INPUT
PB36

SIZE CODE IDENT NO. DRAWING NO.
D 81337 11-1-2520

NOTES:

SYM	COMPONENT	VALUE	TOL
C1	SPRAGUE 118P30592S2	3MFD	10%
C2	SPRAGUE 118P30592S2	3MFD	10%
C3	SPRAGUE 118P30592S2	3MFD	10%
C4	SPRAGUE 118P30592S2	3MFD	10%
C5	SPRAGUE 118P30592S2	3MFD	10%
C6	SPRAGUE 118P30592S2	3MFD	10%
R1	RC20GF183J	18K	5%
R2	RC20GF183J	18K	5%
R3	RC20GF183J	18K	5%
R4	RC20GF183J	18K	5%
R5	RC20GF183J	18K	5%
R6	RC20GF183J	18K	5%



ITEM NO.

QTY REQD

CODE IDENT

PART NO. OR IDENTIFYING NO.

NOMENCLATURE OR DESCRIPTION

MATERIAL

NATL SPEC

DWG NO.

DATE

PREPARED

CHECKED

DESIGNED

APPROVAL

EXTERNAL ACTIVITY

U.S. ARMY MATCH LABORATORIES

DATA RETRIEVAL SYSTEM

RECORDER FILTER

PB21

SIZE CODE IDENT NO

DRAWING NO.

D 81337

11-1-2522